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*Hologram USA, Inc., Musion Das*  
8 *Hologram Limited, and Uwe Maass*

9  
10 **UNITED STATES DISTRICT COURT**  
11 **CENTRAL DISTRICT OF CALIFORNIA**

12 HOLOGRAM USA, INC.; MUSION  
13 DAS HOLOGRAM LIMITED; and UWE  
14 MAASS,

15 Plaintiffs,

16 v.

17 ARENA3D INDUSTRIAL ILLUSION,  
18 LLC; and DOES 1 through 10,

19 Defendants.  
20  
21  
22

**Case No. 14-cv-03072**

**COMPLAINT**

**DEMAND FOR JURY TRIAL**

23 **INTRODUCTION**

24 1. In 1862, John Pepper and Henry Dircks invented “Pepper’s Ghost,” an  
25 illusion technique, which, over the last 150 years, has appeared in movies,  
26 concerts, magic shows and amusement park rides. Walt Disney conjures Pepper’s  
27  
28

1 Ghost daily in Disneyland’s Haunted Mansion. Today, a new incarnation of  
2 Pepper’s Ghost exists – Musion Eyeliner. Musion Eyeliner uses a patented system  
3 to project three-dimensional true-to-life images. Musion Eyeliner’s images are so  
4 realistic they may appear and interact within a live setting. Musion Eyeliner has  
5 gained notoriety around the world for the quality of its holographic projections. In  
6 2012, this technology was used at the Coachella Music Festival to create a three-  
7 dimensional image of deceased rapper Tupac Shakur, who appeared to the  
8 audience as if he were performing live on stage with Dr. Dre and Snoop Dogg.

9       2. Musion Eyeliner is protected by two U.S. patents – U.S. Patent No.  
10 5,865,519 (the “‘519 patent”) and U.S. Patent No. 7,883,212 (the “‘212 patent”  
11 and, along with the ‘519 patent, the “Patents At Issue”). Plaintiff Uwe Maass  
12 holds the ‘519 patent. Plaintiff Musion Das Hologram (“Musion DH”) holds the  
13 ‘212 patent. Maass and Musion DH have licensed certain rights to practice the  
14 Patents At Issue to Plaintiff Hologram USA, Inc. (“Hologram USA”) (collectively,  
15 the “Plaintiffs”). Plaintiffs have entered into agreements to license Musion  
16 Eyeliner technology for use in various settings around the world.

17       3. Plaintiffs have never licensed or otherwise authorized defendant  
18 Arena3D Industrial Illusions, LLC (“Arena3D”) to use their patented Musion  
19 Eyeliner technology. But that has not stopped Arena3D from flagrantly exploiting  
20 Plaintiffs’ intellectual property rights. Arena3D has set up a business that directly  
21 competes with Plaintiffs by making, using, offering to sell, and selling goods and  
22 services that infringe the Patents at Issue. It advertises itself as a low-cost and  
23 “license free” alternative to the Musion Eyeliner technology, but it unlawfully  
24 exploits the same system or method patented by Plaintiffs.

25       4. Arena3D’s willful infringement of the Patents At Issue has damaged  
26 and continues to damage Plaintiffs. Plaintiffs seek to enjoin Arena3D’s wrongful  
27  
28

1 conduct. Plaintiffs also seek damages they have incurred as a result of Arena3D's  
2 infringing conduct.

3 **THE PARTIES**

4 5. Plaintiff Hologram USA, Inc. also known as "Musion" ("Hologram  
5 USA"), is a corporation organized and existing under the laws of the State of  
6 Delaware, having a principal place of business at 301 N. Canon Drive, Beverly  
7 Hills, California 90210.

8 6. Plaintiff Musion Das Hologram Limited ("Musion DH") is a  
9 corporation organized and existing under the laws of the United Kingdom, having  
10 a principal place of business at 90 High Holborn, London, United Kingdom WC1V  
11 6XX.

12 7. Plaintiff Uwe Maass ("Maass") is a citizen of Germany and an  
13 individual residing in Dubai in the United Arab Emirates.

14 8. On information and belief, defendant Arena3D Industrial Illusion,  
15 LLC ("Arena3D") is a limited liability company organized and existing under the  
16 laws of Louisiana, having a principal place of business at 5280 River Oaks Road  
17 South, New Orleans, Louisiana 70123.

18 9. The true names and capacities, whether individual, corporate,  
19 associate, or otherwise, of certain defendants sued in this complaint as DOES 1-10  
20 (the "Doe Defendants") (collectively with Arena3d, the "Defendants"), are  
21 presently unknown to Plaintiffs, who therefore sue them by fictitious  
22 names. Plaintiffs will amend the complaint to allege their true names and  
23 capacities when ascertained. Plaintiffs are informed and believe and therefore  
24 allege that all Defendants were or are, in some way or manner, responsible for the  
25 events, happenings, and damaged alleged in this complaint.

26 10. Plaintiffs are informed and believe and thereon allege that at all times  
27 mentioned each Defendant was the agent, servant, employee, co-venturer,  
28

1 representative, or co-conspirator of each of the other defendants, and acted with the  
2 knowledge, consent, ratification, authorization and/or at the direction of each  
3 defendant, or is otherwise responsible in some manner for the occurrences alleged  
4 in this complaint.

5 **JURISDICTION AND VENUE**

6 11. This is a civil action for patent infringement arising under the Patent  
7 Laws of the United States of America, 35 U.S.C. § 101, *et seq.*

8 12. This Court has jurisdiction over the subject matter of this Complaint  
9 pursuant to 28 U.S.C. §§ 1331 and 1338.

10 13. This Court has personal jurisdiction over Defendants for at least the  
11 following reasons: (i) on information and belief, Defendants regularly do business  
12 or solicit business, engage in other persistent courses of conduct, and/or derive  
13 substantial revenue from products and/or services provided to individuals in this  
14 District and in this State; and (ii) on information and belief, Defendants have  
15 purposefully established substantial, systematic, and continuous contacts with this  
16 District and expect or should reasonably expect to be in court here. Thus, this  
17 Court's exercise of jurisdiction over Defendants will not offend traditional notions  
18 of fair play and substantial justice.

19 14. Venue is proper in this judicial district pursuant to 28 U.S.C. §§  
20 1391(b)-(c) and 1400(b). On information and belief, Defendants do business in  
21 and reside in this District, a substantial part of the events or omissions giving rise  
22 to the claim occurred in this District, and Defendants are subject to personal  
23 jurisdiction in this District.

24 **FACTUAL ALLEGATIONS**

25 **A. Musion Eyeliner**

26 15. The Musion Eyeliner system is an amazing new technique of  
27 projecting video to create the illusion of life-size, full color, 3D moving images.  
28

1 All of the images used in this system are three-dimensional, but are projected as  
2 two-dimensional images into a three-dimensional stage set.

3 16. Musion Eyeliner is protected by patents in the United States. As  
4 described in the '519 and '212 patents, Musion Eyeliner is a proprietary high  
5 definition video projection system that allows moving images to appear within a  
6 live stage setting. A white projection screen or other reflecting surface is placed on  
7 the floor of the stage. An image source (preferably, a computer-controlled  
8 intelligent light amplifier) projects an image onto the reflecting surface, which  
9 projects the image onto a thin transparent foil arranged on stage at an angle of  
10 about 45 degrees. From the audience's perspective, the image produced on the foil  
11 appears as a life-like three-dimensional image.

12 17. Hologram USA has licensed the exclusive right to exploit the Musion  
13 Eyeliner system (including the Patents At Issue) in all markets in the United States  
14 and Canada, with the exception of adult entertainment. Accordingly, Hologram  
15 USA has the exclusive right to use the Musion Eyeliner system and to sublicense  
16 its use to third parties in those territories.

17 **B. Arena3D**

18 18. Arena3D advertises itself as a low cost and "license-free" alternative  
19 to the Musion Eyeliner system. On its website, Arena3D claims that its system "is  
20 package priced for your budget. Once you have purchased it, you own it. We  
21 offer turn key systems as well as 'ala carte' device selection so to speak." See  
22 <http://www.arena3d.com/facts.html>.

23 19. Additionally, Arena3D's website purports to "compare" its product to  
24 the patented Musion Eyeliner system owned by Maass and Musion DH. Arena3D  
25 attempts to differentiate itself through a series of bullet points, writing:

26 **HOW WE STACK UP AGAINST THE**  
27 **COMPETITION**  
28

## ARENA3D®

- we're nice to deal with
- excellent effect
- crystal clear effect foils
- reflectivity / transmission selection choices
- flexible installation routine
- world's largest super-span foils up to 12m x infinite length
- certified NFPA 701 & 702 flame resistant
- LICENSE FREE
- UNRESTRICTED Pepper's Ghost methodology
- you retain ownership
- save at least 25%+ overall costs

## MUSION® UK ...

### MEL/MSL/

March 2014 -- UPDATE -- Musion® UK has split

- excellent effect
- restricted install method
- alarming NDA agreement
- you never own the equipment
- flame resistant
- pay every time you use it
- must buy foils from Musion® UK ... MEL/MSL?
- pay in British Pounds or Euro
- considerably more costly

See <http://www.arena3d.com/compare.html>.

20. Arena3D acknowledges on its website that it is frequently asked if its system infringes on the patented technology developed by Maass. In response to this question, Arena3D claims that “there are other equally good ways to produce the effect not under any patent restriction whatsoever, hence we simply employ one of these. We are happy to educate clients about this.” See <http://www.arena3d.com/facts.html>.

21. Despite the self-serving assertions on its website, Arena3D’s system does infringe on Plaintiffs’ patented technology. On information and belief, Arena3D uses the same tension system and other elements that infringe on one or more claims in the Patents At Issue.

22. Additionally, Arena3D improperly acquired confidential proprietary business information about Plaintiffs’ technology from an ex-employee who used to work for Maass’ company. Arena3D has improperly exploited this proprietary

1 information for its own enrichment in violation of Plaintiffs' rights.

2 23. Arena3D has been placed on notice of its infringing activities, but has  
3 continued to use and sell the patented Musion Eyeliner technology.

4 24. Defendants' infringement of the '519 and '212 patents has caused and  
5 will continue to cause monetary and other damages to Plaintiffs.

6 **FIRST CLAIM FOR RELIEF – Against all Defendants**

7 **(Infringement of Patent No. 5,865,519)**

8 25. Plaintiffs incorporate by reference the preceding averments set forth  
9 in paragraphs 1-24.

10 26. U.S. Patent No. 5,865,519 (“the ‘519 patent”) duly and lawfully  
11 issued on February 2, 1999, to Uwe Maass and is titled “Device For Displaying  
12 Moving Images In The Background Of A Stage.” The claims of the ‘519 patent  
13 are directed at a device or apparatus for representing three-dimensional moving  
14 images in the background of a stage or the like using an image source. A true and  
15 correct copy of the ‘519 patent is attached as Exhibit A.

16 27. Maass is the owner of the ‘519 patent, and Hologram USA has  
17 licensed the exclusive right to exploit this patent in all markets in the U.S. and  
18 Canada with the exception of adult entertainment. Maass and Hologram USA have  
19 the right to bring this suit for injunctive relief and damages.

20 28. On information and belief, Defendants have been, are currently, and  
21 unless enjoined, will continue to directly infringe one or more claims of the ‘519  
22 patent by making, using, offering to sell, and selling within the United States the  
23 patented invention. Arena3D's products and services embody and/or practice one  
24 or more claims of the ‘519 patent.

25 29. Defendants' infringing activities have caused and will continue to  
26 cause Plaintiffs irreparable harm, for which it has no adequate remedy at law,  
27 unless Defendants' infringing activities are enjoined by this Court in accordance  
28



1 with 35 U.S.C. § 283.

2 30. Plaintiffs have been and continue to be damaged by Defendants'  
3 infringement of the '519 patent in an amount to be determined at trial.

4 31. Defendants willfully and deliberately infringe the '519 patent in  
5 disregard of Plaintiffs' rights.

6 **SECOND CLAIM FOR RELIEF – Against all Defendants**

7 **(Infringement of Patent No. 7,883,212)**

8 32. Plaintiffs incorporate by reference the preceding averments set forth  
9 in paragraphs 1-31.

10 33. U.S. Patent No. 7,883,212 (“the ‘212 patent”) duly and lawfully  
11 issued on February 8, 2011, to Ian O’Connell and James Rock and is titled  
12 “Projection Apparatus And Method For Pepper’s Ghost Illusion.” The claims of  
13 the ‘212 patent are directed at a projection apparatus arranged to project an image  
14 of an object upon an inclined, partially reflective screen so as to give a false  
15 perception of depth and a method for constructing such an apparatus. A true and  
16 correct copy of the ‘212 patent is attached as Exhibit B.

17 34. In or about September 2006, Ian O’Connell and James Rock assigned  
18 all their interests in the anticipated application for the ‘212 patent to Musion  
19 Systems Limited. A true and correct copy of the Patent Assignment Abstract of  
20 Title is attached as Exhibit C.

21 35. In or about September 2013, Musion Systems Limited assigned all its  
22 interests in the ‘212 patent to Musion DH.

23 36. Musion DH is the owner of the ‘212 patent, and Hologram USA has  
24 licensed the exclusive right to exploit this patent in all markets in the U.S. and  
25 Canada with the exception of adult entertainment. Musion DH and Hologram  
26 USA have the right to bring this suit for injunctive relief and damages.

27 37. On information and belief, Defendants have been, are currently, and  
28



1 unless enjoined, will continue to directly infringe one or more claims of the '212  
2 patent by making, using, offering to sell, and selling within the United States the  
3 patented invention. Arena3D's products and services embody and/or practice one  
4 or more claims of the '212 patent.

5 38. Defendants' infringing activities have caused and will continue to  
6 cause Plaintiffs irreparable harm, for which it has no adequate remedy at law,  
7 unless Defendants' infringing activities are enjoined by this Court in accordance  
8 with 35 U.S.C. § 283.

9 39. Plaintiffs have been and continue to be damaged by Defendants'  
10 infringement of the '212 patent in an amount to be determined at trial.

11 40. Defendants willfully and deliberately infringe the '212 patent in  
12 disregard of Plaintiffs' rights.

13 **REQUEST FOR RELIEF**

14 WHEREFORE, Plaintiffs respectfully request that:

15 a. Judgment be entered that Defendants have infringed one or more  
16 claims of the '212 and '519 patents;

17 b. Judgment be entered permanently enjoining Defendants, their  
18 directors, officers, agents, servants, and employees, and those acting in privity or in  
19 concert with them, and their subsidiaries, divisions, successors and assigns, from  
20 further acts of infringement of the '212 and '519 patents;

21 c. Judgment be entered that Defendants' infringement has been willful;

22 d. Judgment be entered awarding Plaintiffs all damages adequate to  
23 compensate them for Defendants' infringement of the '212 and '519 patents,  
24 including all pre-judgment and post-judgment interest at the maximum rate  
25 permitted by law, and including a trebling of such damages due to Defendants'  
26 willful infringement.

27 e. For reasonable attorneys' fees incurred in bringing and litigating this  
28

1 action;

2 f. For costs of suit herein; and

3 g. Judgment be entered awarding all other relief as the Court deems  
4 proper.

5  
6 DATED: April 22, 2014

BAKER MARQUART LLP

7  
8 By: \_\_\_\_\_

9  
10 Ryan Baker (Bar No. 214036)  
rbaker@bakermarquart.com

11 *Attorneys for Plaintiffs Hologram USA,*  
12 *Inc., Musion Das Hologram Limited,*  
13 *and Uwe Maass*

14  
15 **DEMAND FOR JURY TRIAL**

16 Please take notice that Plaintiffs demand trial by jury in this action.

17  
18 DATED: April 22, 2014

BAKER MARQUART LLP

19  
20 By: \_\_\_\_\_

21  
22 Ryan Baker (Bar No. 214036)  
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23 *Attorneys for Plaintiffs Hologram USA,*  
24 *Inc., Musion Das Hologram Limited,*  
25 *and Uwe Maass*

# **EXHIBIT A**



US005865519A

**United States Patent** [19]  
**Maass**

[11] **Patent Number:** **5,865,519**  
 [45] **Date of Patent:** **Feb. 2, 1999**

[54] **DEVICE FOR DISPLAYING MOVING IMAGES IN THE BACKGROUND OF A STAGE**

5,573,325 11/1996 Lekowski ..... 353/28  
 5,669,685 9/1997 Kotau et al. .... 353/28  
 5,685,625 11/1997 Beaver ..... 353/28

[76] **Inventor:** **Uwe Maass, Lindlarer Strasse 107, D-51491, Overath, Germany**

**FOREIGN PATENT DOCUMENTS**

389185 9/1908 France .  
 408191 3/1910 France .  
 2714741 7/1995 France .  
 2039680 8/1980 United Kingdom .  
 WO 89/05682 6/1989 WIPO .

[21] **Appl. No.:** **836,911**

[22] **PCT Filed:** **Aug. 31, 1996**

[86] **PCT No.:** **PCT/EP96/03832**

§ 371 Date: **Jul. 7, 1997**

§ 102(e) Date: **Jul. 7, 1997**

[87] **PCT Pub. No.:** **WO97/11405**

**PCT Pub. Date:** **Mar. 27, 1997**

**OTHER PUBLICATIONS**

Rasche et al., *Buhnentechische Rundschau* (1990) BTR 3:24-5.

*Primary Examiner*—William Dowling  
*Attorney, Agent, or Firm*—Klauber & Jackson

[30] **Foreign Application Priority Data**

Sep. 20, 1995 [DE] Germany ..... 295 15 073 U

[51] **Int. Cl.<sup>6</sup>** ..... **G03B 21/28**

[52] **U.S. Cl.** ..... **353/28; 359/630; 472/58**

[58] **Field of Search** ..... **353/28, 98, 30, 353/29, 10; 359/478, 630; 472/58, 61, 63**

[57] **ABSTRACT**

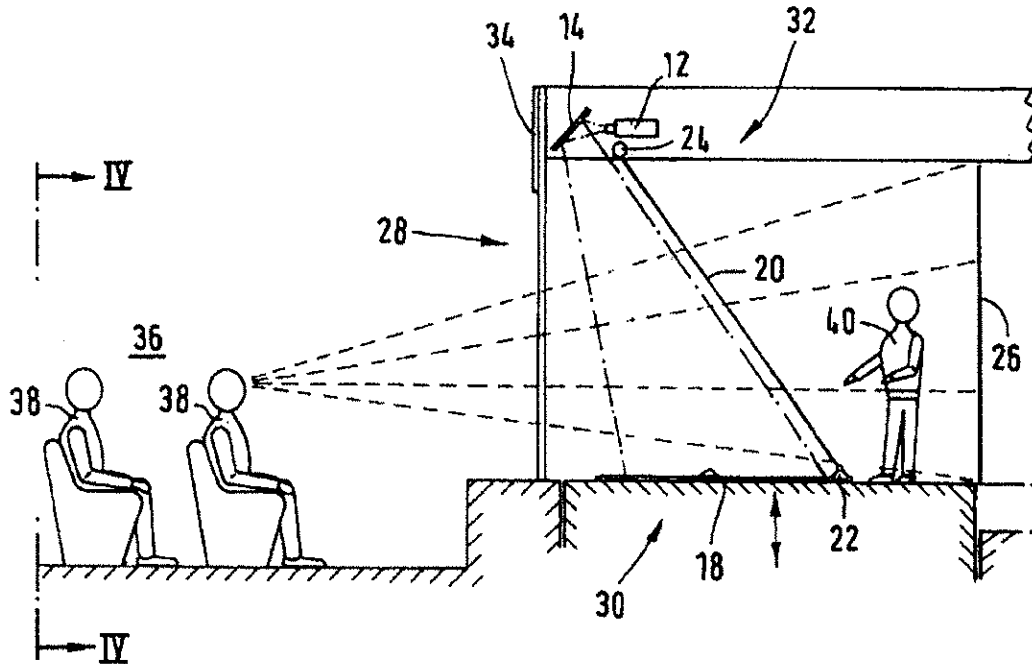
An article such as for example a motor vehicle at a publicity function is to be represented in front of different viewers (38) in the background of a stage (28) in the form of a virtual image (26). A presenter (40) is to stand in the image and give explanations. Disposed above the stage (28) is an image source (12, 14). It projects an image, a film, on to a reflecting surface (18) on the floor (30) of the stage (28). Behind that reflecting surface (18) a transparent smooth foil (20) extends at 45° from the ceiling (32) to the floor (30). The image produced by the image source (12, 14) appears to the viewers (38) as a virtual image (26) behind the foil (20). The presenter (40) stands behind the foil (20) and in the middle of the image.

[56] **References Cited**

**U.S. PATENT DOCUMENTS**

1,053,887 2/1913 Sontag .  
 1,358,110 11/1920 Presicce .  
 2,198,815 4/1940 Haskin .  
 3,035,836 5/1962 McCulley ..... 353/28  
 4,805,895 2/1989 Rogers .

**15 Claims, 5 Drawing Sheets**



U.S. Patent

Feb. 2, 1999

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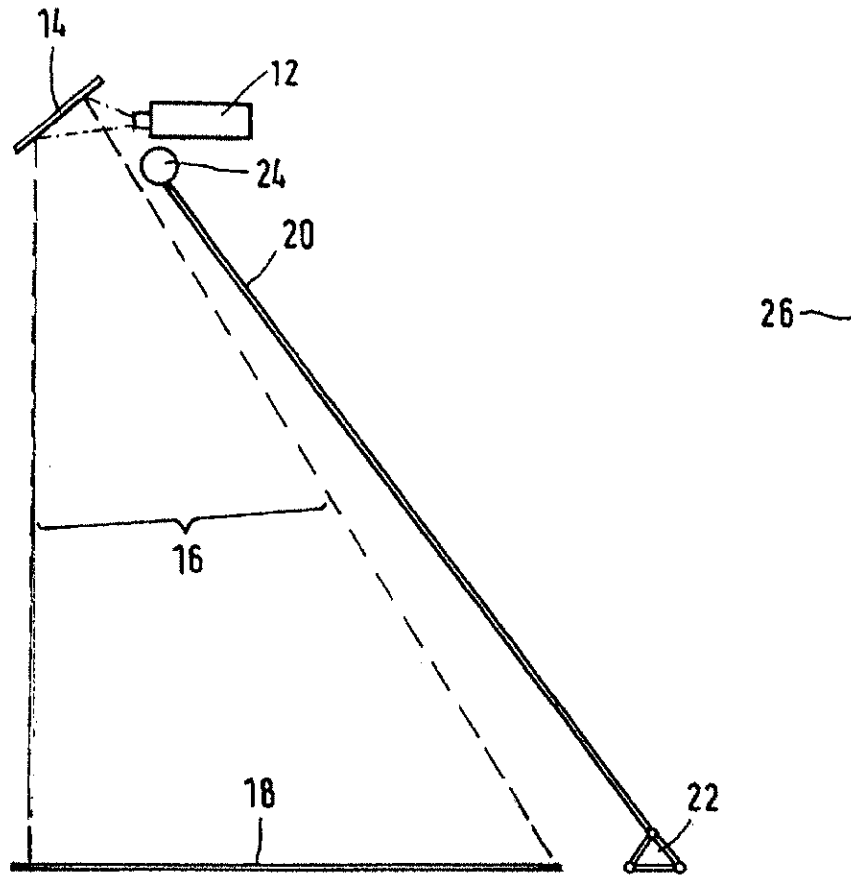


FIG.1

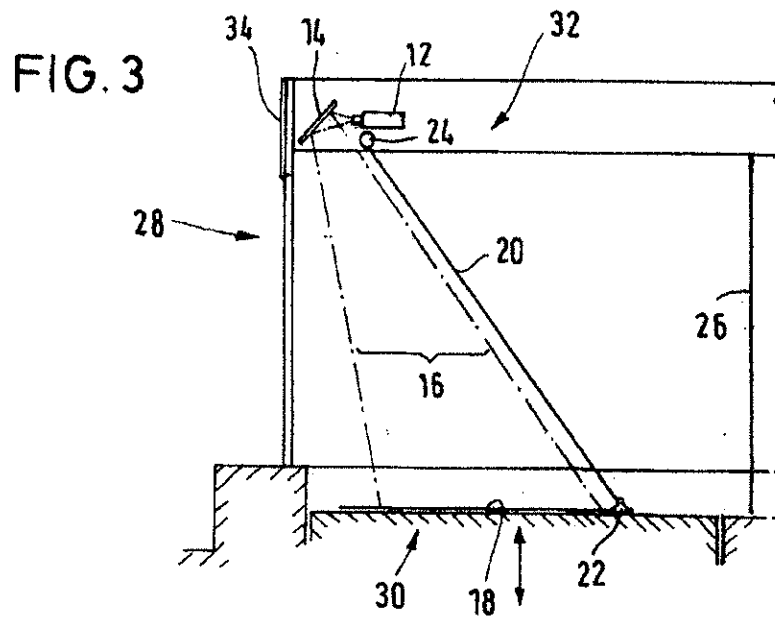
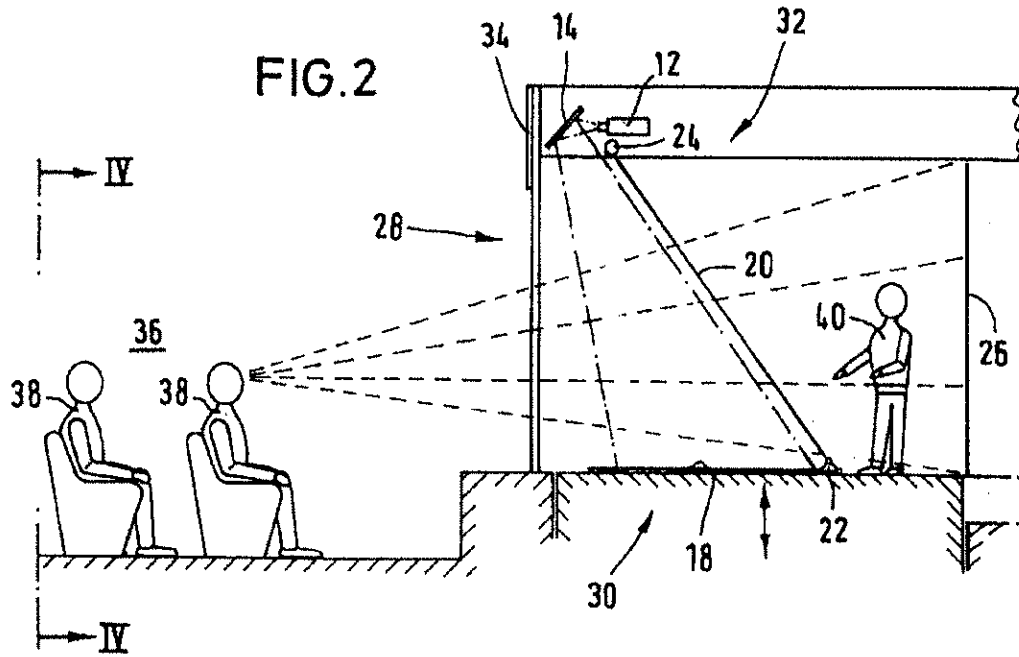
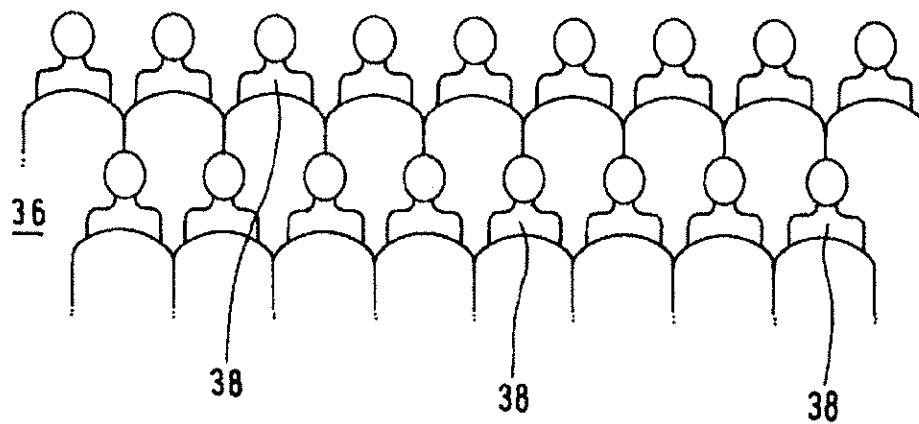
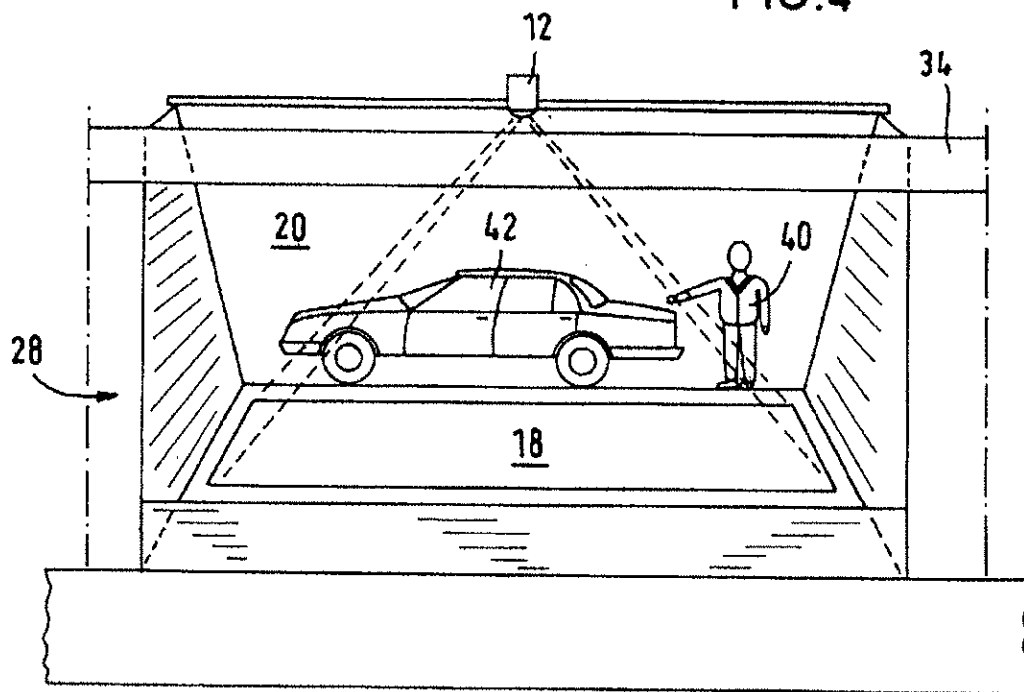


FIG. 4







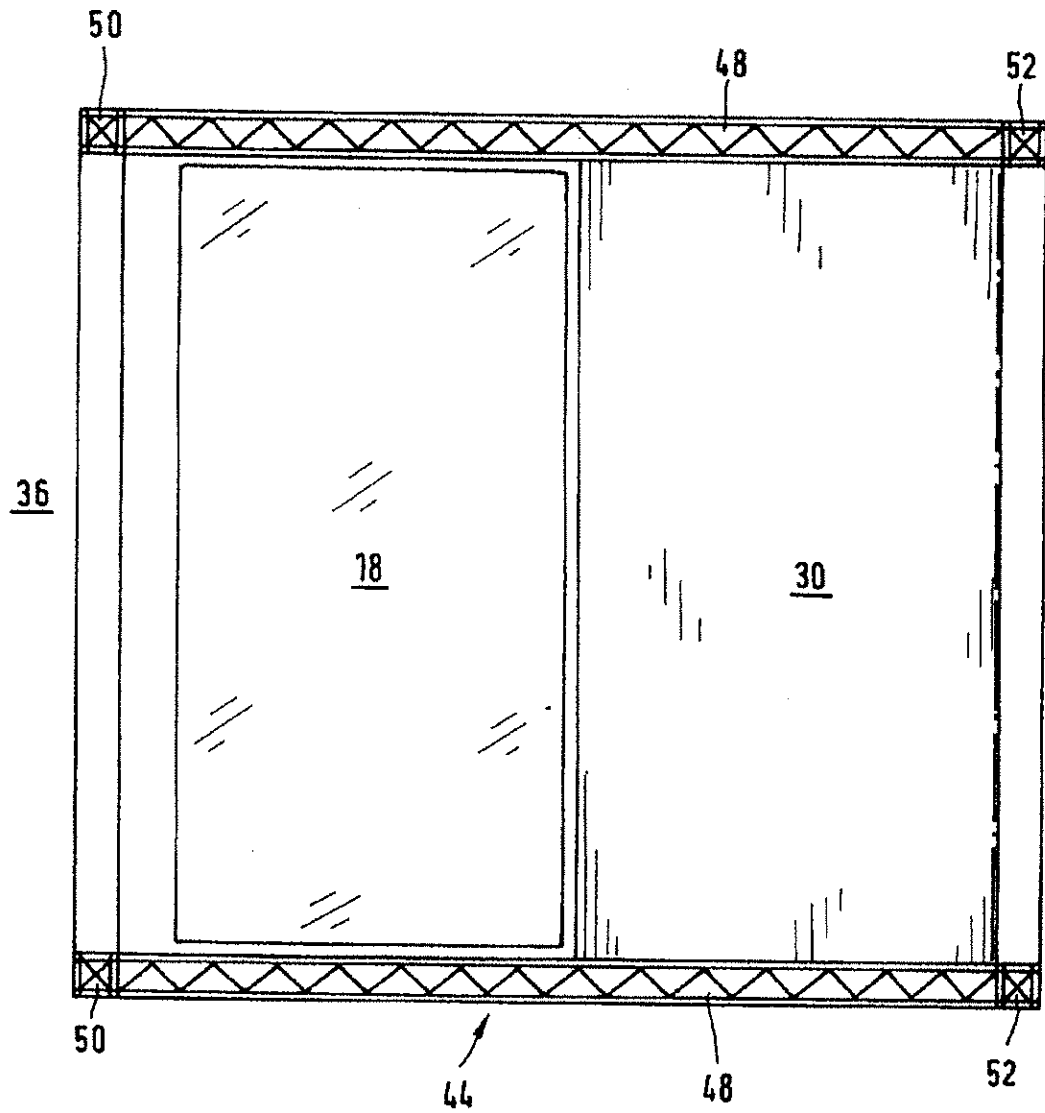
U.S. Patent

Feb. 2, 1999

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FIG. 6



5,865,519

1

**DEVICE FOR DISPLAYING MOVING  
IMAGES IN THE BACKGROUND OF A  
STAGE**

The invention concerns an apparatus for representing moving images in the background of a stage or the like using an image source.

Transparency lectures or presentations are known, and that expression is a well-established piece of terminology. In a transparency presentation the presenter projects still images or pictures on to a projection screen. The presenter himself stands outside the light cone between the projector and the projection screen and comments on the images. Instead of the transparency projector the presenter can also use a film apparatus. In that case moving images appear on the projection screen and the presenter comments thereon. In both cases the presenter stands outside the light cone. He does not appear on or in the image himself. If he were to move into the light cone he would mask off a part of the light beam. Instead of the image, the shadow of the presenter would then appear on the projection screen. If the presenter wants to direct the attention of his viewers to a given point in the image he uses for that purpose a pointer or a light with a sharply focussed light beam.

The foregoing kind of presentation is sufficient for image and film presentations for photographic and film amateurs. Travellers who show films or transparencies of their travels to a wide circle of viewers can also use that kind of presentation without detriment. The viewers are only interested in the film or the transparencies and the words of the presenter. They attribute only slight significance to the manner of presentation and the technical equipment involved.

The position is different if the viewers do not have any particular interest in the articles to be shown and an interest first has to be aroused. The position is also different when the film presentation is to take place at a high technical level, for overriding reasons. The situation is also different if the film presentation is to be made more relaxed and less monotonous and linked to so-called display effects.

A theatre production is described as a ghost trick in the literature (for example *Bühnentechnische Rundschau*, BTR 3/1990, pages 24 and 25), involving disposing a pane of glass inclinedly in the front region of the stage. An actor is positioned beneath the pane of glass and in a lowered part of the stage. He is bedecked with wide white garments and represents the ghost. He is lit by a spotlight which is also disposed under the stage. The image of that actor representing the ghost is projected on to the pane of glass and appears to the viewers behind the pane of glass a virtual image. In that theatre presentation a second actor is on the stage. He represents a hero or sorcerer who conjures up the ghost.

On the basis thereof, the object of the present invention is an apparatus with which film and image presentations can be made relaxed and the presenter himself can move into the image without thereby interfering with reproduction of the image on a projection screen or generally on a surface. In accordance with the invention, that object is attained in an apparatus of the kind set forth in the opening part of this specification, in that a reflecting surface is arranged on the floor of the stage in the central region thereof, a transparent smooth foil extends between the floor and the top or ceiling of the stage over the entire width thereof in such a way that its lower end is held to a position between the reflecting surface and the background and its upper end is held to the ceiling at a position which is disposed further forwardly, and the image source is arranged at the ceiling in front of the

2

upper end of the foil which is held there, and is directed on to the reflecting surface.

The apparatus according to the invention makes use of the physical principle that any motor car driver experiences on the windshield of his vehicle. An article lying on the storage surface in front of the windshield is reflected therein in such a way that it seems to the motor car driver to be disposed in front of the windshield, as viewed in the direction of travel. In the case of the apparatus according to the invention the article to be represented is projected by the image source on to the reflecting surface which corresponds to the above-mentioned support surface, and it is then reflected in the transparent smooth foil in such a way that it appears to the viewer on the background of the stage. The foil which extends over the entire width of the stage and which is held to the floor and ceiling thereof acts like the windshield in a motor vehicle. A viewer at any point in the auditorium believes that he is seeing any article reflected by the reflecting surface on to the foil, behind same. The presenter stands on the stage outside the light cone of the image source. As viewed from the auditorium, he stands behind the reflecting surface. That means that his image is not formed on the background, nor does he disturb the image representation thereon. He can draw the attention of the viewers to given details in the image representation, without making use of a pointer or a light. He can likewise move with the images and interpret the reproduction thereof by virtue of his body language.

Desirably the foil extends at an angle of about 45° relative to the floor of the stage. The image source can be a display screen tube with a very high degree of resolution. It can be controlled by a computer. That means that the image can also be electronically influenced. Desirably a computer-controlled intelligent light amplifier (also known as an ILA) is used as the image source. It is oriented horizontally and emits light in the direction of the auditorium. Accordingly its longest extent lies in the horizontal and it can be easily concealed from the viewers. So that the light which it radiates reaches the reflecting surface, a further embodiment provides that a mirror is arranged in front of the computer-controlled light amplifier and the latter is directed on to the mirror and the mirror receives the light emitted by the light amplifier, is directed on to the reflecting surface and projects the light on to same.

If possible the viewer should not notice how the image in the background of the stage is produced. Therefore the light amplifier and the mirror are desirably covered over forwardly by a curtain or a board which extends over the entire width of the stage. The foil itself is under a very high tensile stress of up to 8t. In that way it is held tautly smooth and the image is not distorted. The foil is preferably without any inclusions. It is also to be very smooth on its front side and its rear side. It is also to be very thin. Finally the foil is to reflect between 30 and 50%, preferably 30%, of the light impinging on it. Such a foil is particularly well suited for the purposes according to the invention. The absence of inclusions and the smooth front and rear sides thereof result in very slight and imperceptible distortion effects. The fact that the foil is very thin serves the same purpose. Reflection phenomena at the front and rear sides thereof thus coincide. The foil used for the purposes according to the invention is generally subjected to further processing as transparency or 35 mm films. When used as a transparency film, it is cut up into the format of the transparency or 35 mm films. When it is used for the invention the foil has a surface area of at least 3 m times 4 m.

In a desirable embodiment the foil is rolled on to a winding tube. It is suspended therewith at the ceiling of the

5,865,519

3

stage. Desirably it is fixed to the ceiling, together with the intelligent light amplifier. The free end of the foil can be pulled off the winding tube and is fixed to the floor of the stage. A support mounting arranged on the floor of the stage is used for that purpose.

The reflecting surface may be a white projection screen which is to be laid on to the floor of the stage. The reflecting surface however may also be a simple white coat of paint. As the presenter moves outside it and more specifically behind it, it retains its reflecting properties for a very long period of time.

The apparatus according to the invention is advantageously used in connection with a stage with a floor which can be raised and lowered. The reflecting surface, the projection screen, the coat of paint or the like, is disposed on that part of the floor, which can be raised and lowered. When the floor is lowered the spacing between the image source and the reflecting surface is increased. As a result the virtual image which appears in the background of the stage is displaced rearwardly.

The apparatus according to the invention is to be easy to transport from one location to another and to set up at different locations. For that purpose, in a desirable embodiment, the invention provides that its components are enclosed by a lattice frame and can be secured thereto. Desirably, the lattice frame has units which can be set up on the two sides of the apparatus or the stage thereof and which each have a lower girder portion, an upper girder portion, a front girder portion and a back girder portion. The lattice frame units which can be set up on the two sides of the apparatus or stage can be connected together by transversely extending struts.

Desirably the winding tube is secured to the upper girder portions by way of brackets while the mounting support which holds the free end of the foil is fixed to the lower girder portions.

The invention will now be further described by way of the example of the embodiments illustrated in the drawing in which:

FIG. 1 is a simplified diagrammatic side view of the apparatus according to the invention,

FIG. 2 is a more detailed diagrammatic side view of the apparatus according to the invention, simultaneously showing the auditorium,

FIG. 3 is a side view of the stage similarly to the illustration in FIG. 2 with the floor lowered,

FIG. 4 is a view of the auditorium and the stage looking in the direction of the line IV—IV in FIG. 2,

FIG. 5 is a side view of the apparatus according to the invention when using the lattice frames surrounding it, and

FIG. 6 is a view in the direction of the line VI—VI.

FIG. 1 shows the physical principle of the apparatus according to the invention with the computer-controlled intelligent light amplifier 12 which acts as an image source, the mirror 14 which in the view in FIG. 1 is arranged to the left in front of it and which projects the light radiated on to it from the light amplifier 12 on to the reflecting surface 18 in the form of a light cone 16 as indicated by two broken lines, the foil 20 with its lower holding means in the form of a mounting bracket 22 and its upper holding means in the form of a winding tube 24 and the virtual image 26 which is represented in the background of the stage. The computer-controlled intelligent light amplifier 12 projects a moving image on to the mirror 14. This projects it on to the reflecting surface 18 which projects it on to the foil 20. From the point of view of a viewer who is at the left in FIG. 1—see FIG. 2—a moving image appears in the background as a virtual image 26.

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FIGS. 2 and 3 show a practical application of the apparatus according to the invention at a presentation or lecture function. More specifically FIG. 2 again shows the stage 28, the floor 30 thereof and the ceiling 32 thereof. Extending under the ceiling 32 of the stage 28 over the entire width thereof is a curtain or a cover rail or board 34. It covers over in a forward direction the computer-controlled intelligent light amplifier 12 and the mirror 14. The viewers 38 sit in the auditorium 36. The presenter or lecturer 40 stands on the stage 28 behind the reflecting surface 18. The reflecting surface 18 is for example a projection screen or a coat of white paint. The double-headed arrow shown under the floor 30 is intended to indicate that it can be raised and lowered. FIG. 2 shows the floor 30 at its normal height. The virtual image 26 appears in the background of the stage 28 at a given location. FIG. 3 shows the same stage 28 with the floor 30 lowered. When the floor 30 is lowered the virtual image 26 moves rearwardly, towards the right when looking at FIGS. 2 and 3.

FIG. 4 shows a practical application of the apparatus according to the invention in a presentation function relating to motor vehicles. FIG. 4 shows a presentation article 42, in this example being a motor vehicle. The viewers 38 see it in the background as a virtual image. They do not recognise that this involves a reflection at the reflecting surface 18 and the foil 20. They only see how the presenter 40 moves freely in front of the motor vehicle, points with his arms and hands to the motor vehicle and parts thereof, explains details in words, and in so doing neither interferes with nor in any way influences the reproduction of the motor vehicle in the background in the form of the virtual image 26.

FIGS. 5 and 6 show the transportable embodiment of the apparatus according to the invention, which can be set up at any desired location. Lattice frames 44 which can be set up at both sides of the apparatus serve for that purpose. Each lattice frame comprises a lower girder portion 46, an upper girder portion 48, a front girder portion 50 and a back girder portion 52. Lattice frames of that kind are known. Each girder portion comprises a plurality of parts which can be releasably connected together. For the purposes of erecting the apparatus, the parts of the girder portions are fitted together and joined together. For transportation purposes they are separated from each other and can be transported in the form of comparatively small units on a truck or the like. As shown in FIG. 5 the computer-controlled intelligent light amplifier 12 and the winding tube 24 are fixed to a bracket. The bracket is in turn fixed to a transverse strut which connects the two upper girder portions 48. The same applies in regard to the mirror 14. When the apparatus is erected the foil 20 is pulled off the winding tube 24, fixed to the mounting bracket 22 and then tensioned. The reflecting surface 18 is laid on the floor in the form of a plate or the like which is coated or painted white, or in the form of a projection screen. The stage 28 on which the presenter 40 stands when making his presentation is composed of parts which are known per se on their own and it is erected in the rearward region of the apparatus.

I claim:

1. Apparatus for representing moving images in the background of a stage using an image source, said stage including a floor, a ceiling disposed vertically above said floor and a background disposed therebetween, said apparatus characterised in that a reflecting surface (18) is arranged on said floor (30) of said stage (28) in the central region thereof, a transparent smooth foil (20) extends between said floor (30) and said ceiling (32) at a position which is disposed further forwardly, and the image source is arranged at the ceiling

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(32) in front of the upper end of the foil (20) which is held there, and is directed on to the reflecting surface (18).

2. Apparatus as set forth in claim 1 characterised in that the foil (18) extends at an angle of about 45° relative to the floor (30) of the stage (28).

3. Apparatus as set forth in claim 1 or claim 2 characterised in that the image source is a computer-controlled intelligent light amplifier (12).

4. Apparatus as set forth in claim 3 characterised in that a mirror (14) is arranged in front of the computer-controlled light amplifier (12) and said light amplifier is directed on to the mirror (14) and the mirror (14) receives the light radiated from the light amplifier (12), is directed on to the reflecting surface (18) and projects the light on to said reflecting surface.

5. Apparatus as set forth in claim 4 characterised in that the light amplifier (12) and the mirror (14) are covered over forwardly by a curtain extending over the entire width of the stage (28).

6. Apparatus as set forth in claim 1 characterised in that the foil is subject to a tensile stress.

7. Apparatus as set forth in claim 6 characterised in that the foil (20) has a surface area of at least 3 m times 4 m.

8. Apparatus as set forth in claim 7 characterised in that the foil (20) is rolled on a winding tube (24) and can be pulled off same and can be fixed with its free end in a support mounting (22).

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9. Apparatus as set forth in claim 1 characterised in that the reflecting surface (18) is a coat of white paint.

10. Apparatus as set forth in claim 1 characterised in that the reflecting surface (18) is a white projection screen.

11. Apparatus as set forth in claim 1 characterised in that the floor (30) of the stage (28) can be raised and lowered.

12. Apparatus as set forth in claim 4 characterised in that light amplifier (12), mirror (14), reflecting surface (18), foil (20) and stage (28) are enclosed by a lattice frame (44) and can be fixed thereto.

13. Apparatus as set forth in claim 12 characterised in that the lattice frame (44) includes two units which can be set up on both sides of the stage (28) and each unit has a lower girder portion (46), an upper girder portion (48), a front girder portion (50) and a back girder portion (52).

14. Apparatus as set forth in claim 13 characterised in that the two lattice frame units which can be set up on both sides of the stage (28) can be connected by transversely extending struts.

15. Apparatus as set forth in claim 4 characterised that the light amplifier (12) and the mirror (14) are covered over forwardly by a cover bar (34) extending over the entire width of the stage (28).

\* \* \* \* \*

# **EXHIBIT B**



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**O'Connell et al.**

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 (45) **Date of Patent:** **Feb. 8, 2011**

(54) **PROJECTION APPARATUS AND METHOD FOR PEPPER'S GHOST ILLUSION**

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(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1129 days.

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(57) **ABSTRACT**

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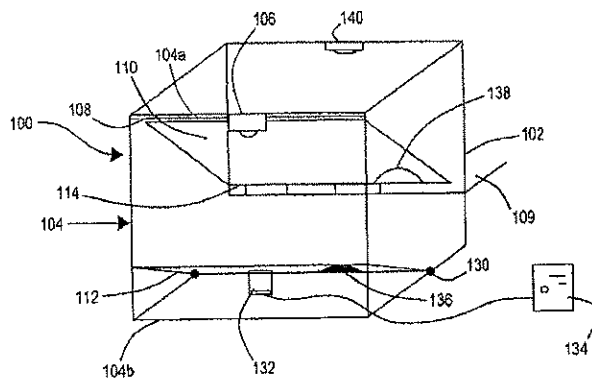
(51) **Int. Cl.**  
**G03B 21/00** (2006.01)  
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An image projection apparatus (100) comprises a projector (106), a frame (108), and a partially transparent screen (110). The frame (108) retains the screen (110) under tension, such that the screen (110) is inclined at an angle with respect to a plane of emission of light from the projector (106). The screen (110) has a front surface arranged such that light emitted from the projector (106) is reflected therefrom. The projector (106) projects an image such that light forming the image impinges upon the screen (11) such that a virtual image is created from light reflected from the screen (110), the virtual image appearing to be located behind the screen (110).

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See application file for complete search history.

**18 Claims, 4 Drawing Sheets**





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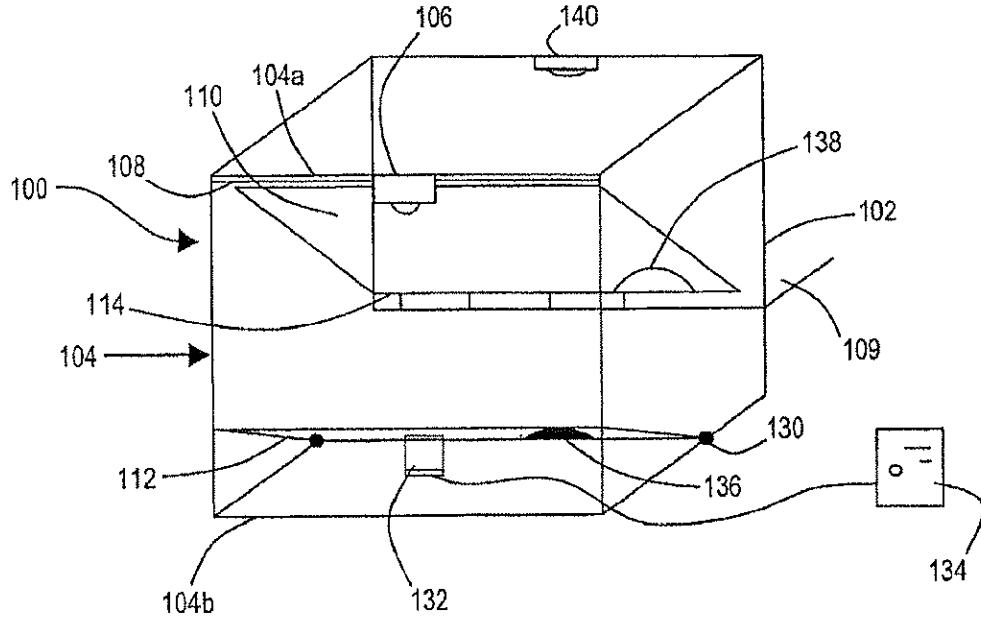
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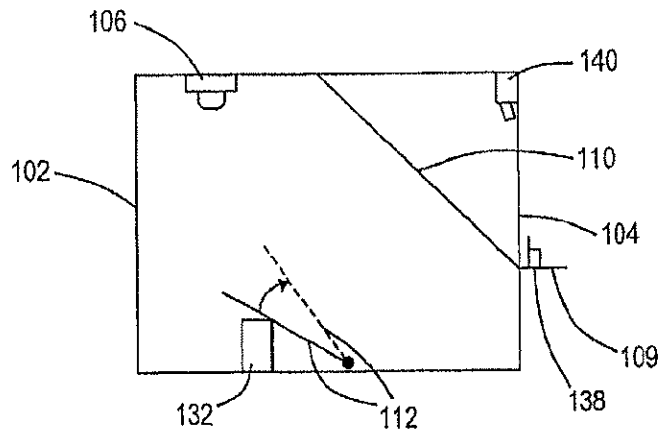
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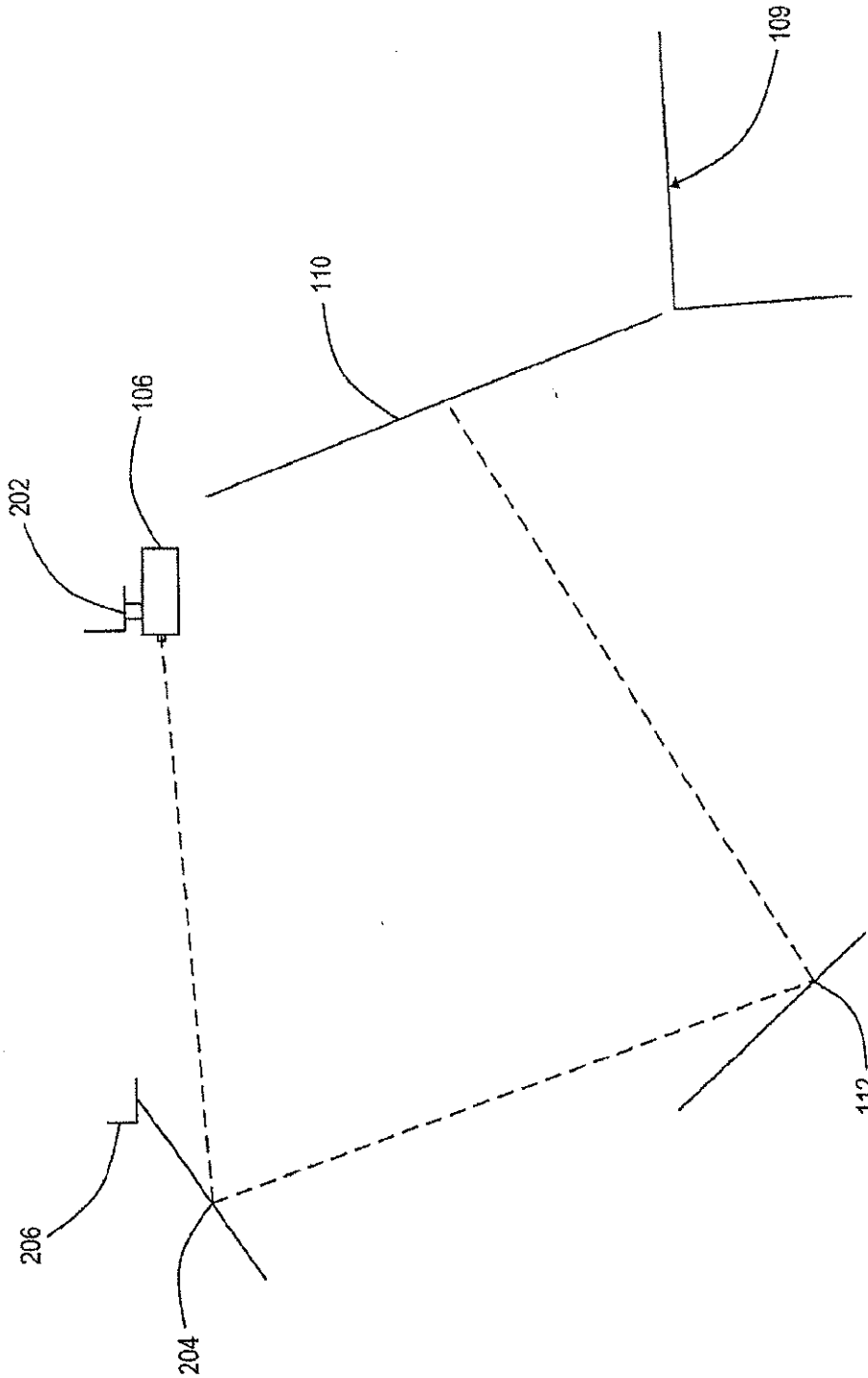
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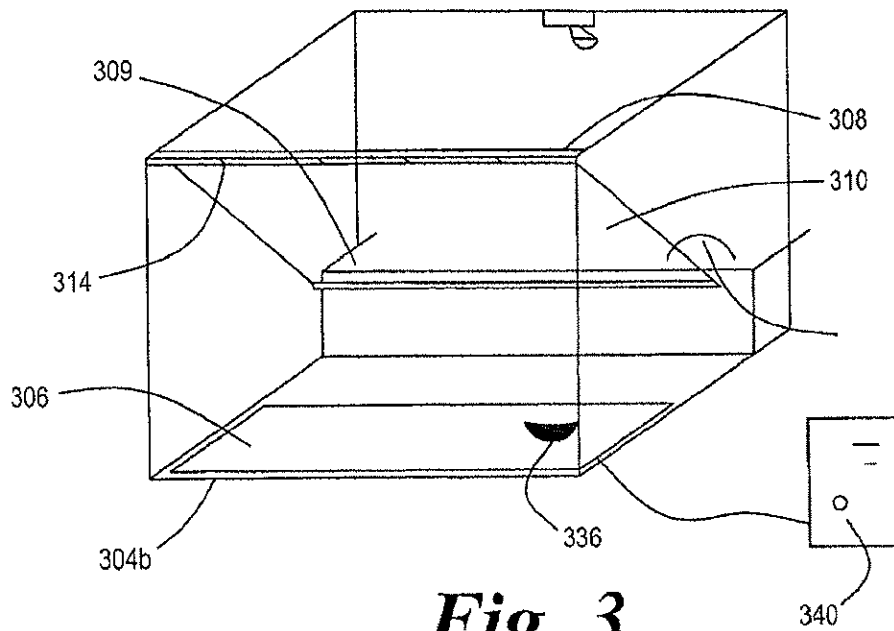
*Fig. 1*



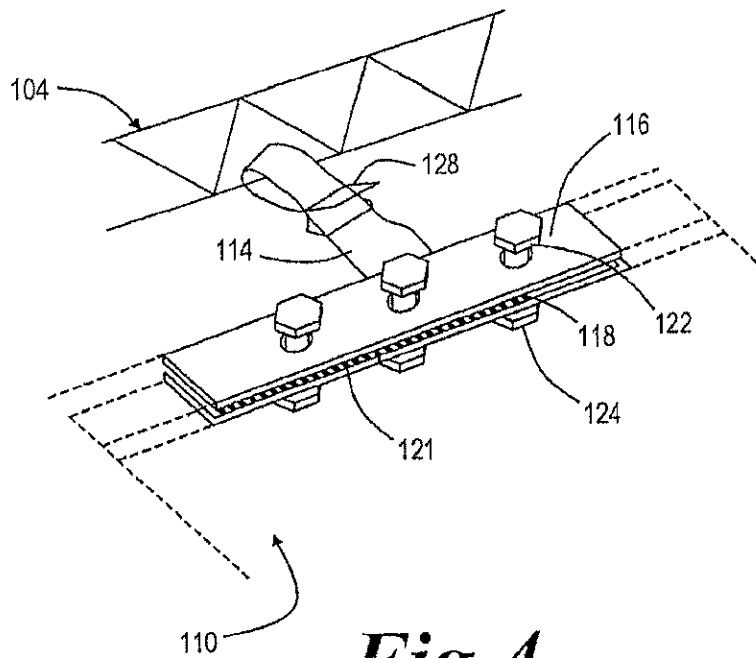
*Fig. 2*



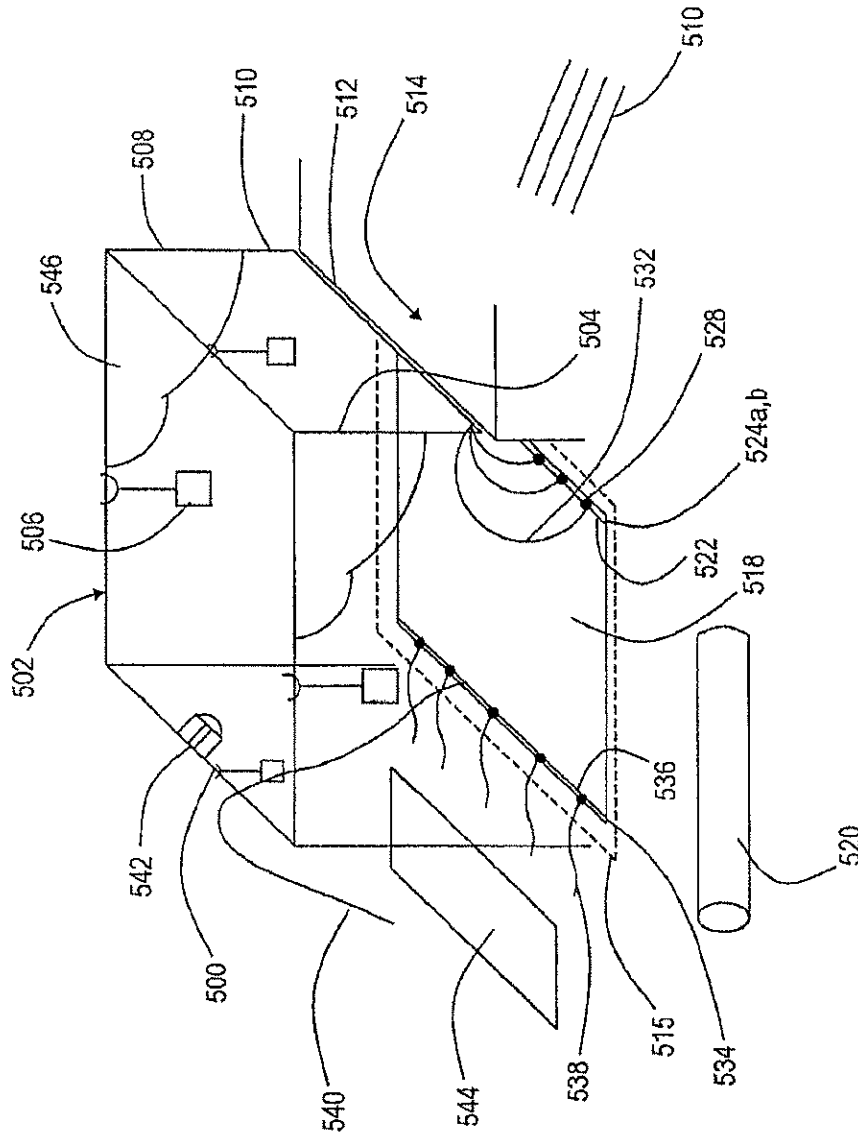
*Fig. 2a*



*Fig. 3*



*Fig. 4*



*Fig. 5*

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## PROJECTION APPARATUS AND METHOD FOR PEPPER'S GHOST ILLUSION

This invention relates to a projection apparatus and method. More particularly, but not exclusively, it relates to a projection apparatus arranged to project an image of an object upon an inclined, partially reflective, screen so as to give a false perception of depth and a method for constructing such an apparatus.

### BACKGROUND OF THE INVENTION

The projection of an image upon a partially reflective screen such that is observable by a viewer positioned in front of the screen is known, the so-called "Peppers ghost" arrangement that is known from fairground shows.

This has been applied to publicity and promotional displays where a presenter resides behind an inclined, partially reflective screen, typically a tensioned foil, onto which an image of, for example, a motor vehicle is projected, via at least one reflective surface, see for example EP 0799436. The location of the presenter behind the projected image has a number of inherent advantages over systems where the presenter stands in front of a screen, not least of which is that the presenter does not obscure the projected image when walking across the projected image. Additionally, the use of an inclined screen results in a viewer of the image perceiving the image as having depth rather than merely being a two dimensional image, for example where a motor vehicle is seen to rotate upon a turntable.

However, current image projection apparatus' do have a number of problems associated with them, for example, mounting of the foil can prove difficult which in turn leads to uneven tensioning of the foil and wrinkles upon the foil, that impair the viewed quality of the image projected onto the foil. Also, in mounting the foil the foil must be laid out upon a clean dust free piece of cloth or plastic sheet, which is larger than the foil, in order to prevent particles adhering to the foil, such particles can scratch the surface of the foil and impair the viewed quality of the projected image or act as scattering centres from which projected light is incoherently scattered, thereby detracting from the viewed quality of the image as this scattered light does not contribute to the viewed image.

Also, as the illusion of peppers ghost relies on the reflected image formed by light contrasting with its immediate surroundings and background. The stronger the reflected image, the more solid that reflected image looks, the more vibrant the colours will be, and the more visible the reflected image is to an audience. In circumstances where the presenter may be unable to control high levels of ambient light forward of the foil, e.g. from an auditorium at a trade show, the high level of ambient light results in significant levels of reflection of the ambient light from the screen detracting from the strength of the reflected image over the background. In these circumstances a bright projector (8000 lumens+) is desirable. However, the use of a bright projector results in unwanted light hitting the projection surface and reflecting through the foil to create a milky hue upon the stage and around the area where the reflected image appears.

Another problem with current image projection apparatus is that projectors used with such apparatus are very powerful, typically 8,000 to 27,000 lumens and consequently project a significant amount of light into areas of an image where there is no object within the image. This is an inherent feature of projectors and results in low contrast ratios which leads to a milky hue spread over the part of the film where the projector is creating an image when the projector is switched on. The

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milky hue is clearly undesirable as it detracts from the viewer's perception that there is no screen present.

The level of the milky hue relative to the brightness of the image is, at least partially, determined by the level of contrast ratio offered in the projector. The higher the contrast ratio, then the brighter the image can be relative to the brightness level of the milky hue. Even projectors with contrast ratios as high as 3000:1 still emit a milky light hue when used in a "Pepper's Ghost" arrangement.

A further problem associated with some projectors is the "keystone" effect, in which distorted, typically elongated, images (up and down) occur due to angled projection. This is of particular relevance where depth perception is of importance. The solution employed in modern, expensive projectors is to employ digital correction of keystone distortions. However, older, less-expensive or even some specialist High Definition projectors do not employ such digital keystone correction and are therefore difficult to configure for use with current image projection apparatus. High definition (HD) projectors do not offer keystone adjustment because when keystone correction is attempted in conjunction with the increased number of pixels about an image's edge causes the pixels about the edge of the image to appear 'crunched'. Additionally, when processing moving images HD projectors compromise projector processing speed. When the processing power is used to carry out both keystone correction and motion processing the image is seen to jerk during movements, an effect known as "chokking". In general, it can be said that the use of electronic keystone correction to alter a video image will result in the degradation of picture quality compared to an image which is not subject to such a process.

Additionally, current systems do not allow for the projected image to apparently disappear and re-appear from behind a solid 3D object placed upon the stage, as the screen lies in front of the presenter and closest to the viewing audience.

### BRIEF SUMMARY OF THE INVENTION

According to a first aspect of the present invention there is provided a image projection apparatus comprising a projector, a frame, and an at least partially transparent screen:

the frame being arranged to retain the screen under tension, such that the screen is inclined at an angle with respect to a plane of emission of light from the projector;

the screen having a front surface arranged such that light emitted from the projector is reflected therefrom; and

the projector being arranged to project an image such that light forming the image impinges upon the screen such that a virtual image is created from light reflected from the screen, the virtual image appearing to be located behind the screen.

Such an apparatus is advantageous over present systems in that the screen need not be coated with an expensive, partially reflective coating, an angular dependence of reflectivity of transparent dielectric materials can be used to bring about partial reflectance of the projected image. Thus, this apparatus simplifies the manufacture of such systems and also reduces their production costs. Additionally, the use of a frame frees the screen from having to be fixed directly to a ceiling, or a floor, and therefore increases the utility of apparatus over the prior art systems.

The screen may be a foil. The foil may be rolled about a cylinder when not in use. The screen may be inclined at approximately 45° to the plane of emission of light from the projector. The screen may comprise a partially reflective layer upon the front surface.

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The use of a foil screen reduces the weight of the apparatus, this allows ready transportation of the apparatus between sites. Rolling the foil onto a cylinder when not in use serves to protect the foil from damage during transportation and also allows ready transportation of the apparatus between sites. The use of a partially reflective screen can increase the degree of light reflected from the screen and can increase the audience perceived strength of the virtual image.

The screen may be attached to the frame at the screen's upper and/or lower edges. The frame may comprise first and second retention members arranged to sandwich an edge region of the screen therebetween. At least one of the first and second retention members may comprise an abrasive coating, typically sandpaper, arranged to contact the screen. The first and second retention members may comprise respective openings therethrough that may be arranged to collocate with openings in respective jaws of clamping members attached to tensioning straps, the openings may be arranged to receive a fixing means so as to clamp the screen between the first and second retention members. The tensioning straps may be attached to a truss arrangement and may be adjustable such that the tension of the screen within the truss arrangement can be varied about the periphery of the screen. Preferably, the retention members are substantially parallel to truss members comprising the truss arrangement.

The use of a variable tensioning arrangement allows wrinkles upon the screen to be minimised, and ideally eradicated to present a smooth surface for upon which the image can be projected. An abrasive surface upon at least one of the retention members increases the grip between the retention member and the screen thereby reducing the likelihood of the screen slipping when held by the retention member.

The apparatus may comprise a pigmented reflective member in an optical pathway between the projector and the screen. The pigmented member may reflect only part of the visible spectrum of light, typically the pigmented member will appear grey or white to a viewer.

It has been found that the use of a grey reflective member in the optical pathway between the projector and the screen reduces the outline of the reflective member upon the screen compared to when a white reflective member is used, and also reduces the level of the milky white hue associated with the projector emitting light where there is no image of an object to be projected.

The pigmented reflective member may be inclined at an angle with respect to the plane of emission of light from the projector. The angle of inclination of the member with respect to the plane of emission of light from the projector may be variable. The member may comprise a plurality of sections each of which may have an independently variable angle of inclination with respect to the plane of emission of light from the projector.

The inclination of the reflective member can compensate, at least partially and in some instances completely, for keystone effect. The variation of the angle of inclination or distance of the reflective member allows for a variation of the apparent depth and/or position of an object when projected upon the screen. This is because the virtual image appears as far behind the screen as the real image is in front of the screen.

There may be a reflective device, typically a mirror, arranged to direct light projected from the projector on to the reflective member. Typically, the reflective device is mounted upon an upper part of the framework. The reflective member may be parallel, or substantially parallel, to the reflective device. In some embodiments the projector may be mounted upon an upper truss of the framework and may be aligned with

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the horizontal, typically light projected from the projector is directed on to the reflective device.

Such an arrangement compliments the keystone correction achievable by the inclination of the screen and the reflective member and is particularly useful where an HD projector is used in order to compensate for the keystone effect without the use of the projector's processing power.

The reflective member may comprise a mask corresponding to the apparent location of a prop in the screen to an audience. Typically, the mask will absorb light over at least a fraction of the visible spectrum and preferably the mask will be black. The mask may be arranged to produce an area upon the screen upon which the image is not projected. The mask may vary in extent and shape, for example by the use of a sliding element that is moved in and out of position upon the reflective member.

The mask can be used to make the illusion of an article disappearing and reappearing behind a prop that is placed upon a stage, either behind or in front of the screen.

The apparatus may comprise a light source arranged to selectively illuminate an area of stage comprising the prop. The light source may be a white light source. Lighting the prop causes the prop to become more visible and better defined against the dark, typically black, background. This enhances the three dimensional effect of the projected image interacting with the prop.

Also directing bright light upon the prop serves to reduce the contrast ratio of the projected image upon the prop, which typically remains slightly visible even when a mask is used in the prop's shadow upon the reflective member, thus enhancing the illusion of the projected image disappearing behind the prop.

The apparatus may comprise a light source arranged to illuminate at least part of a stage. The light source may be located to the rear of the screen, typically along a top edge of the frame and/or along either side of the stage. The apparatus may comprise a plurality of light sources. The apparatus may comprise a lighting desk equipped with faders arranged to control the level of each light source, or selection means arranged to selectively control the supply of power to each light source.

Such a light source is used in order that the colour and light levels of the area immediately surrounding the peppers ghost image, the stage background, can most closely match the colour of the projection surface background, excluding the area on both which is carrying the image. This, reduces the milky hue perceived by the audience. The use of a plurality of light sources increases the uniformity of lighting of the stage, in order to produce a similar effect to the way light emitted from a projector hits the projection screen. By controlling each light source separately the lighting levels upon the stage can be controlled to closely match the levels of light as dictated by the show performance, or the levels of unwanted light hitting the projection surface of the screen.

The projector may comprise a standard projector, for example a JVC ML4000, or a Barco G5. Alternatively, the projector may comprise an LCD, or a television display. The display may comprise at least one element arranged to be non-emitting in response to control from a processor. The at least one element may form a mask arranged to produce an area upon the screen upon which the image is not projected. The mask may correspond to the shape and location of a prop upon a stage. The prop may be three dimensional.



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According to a second aspect of the present invention there is provided a method of providing a projection apparatus comprising the steps of:

- (i) resting a frame upon a number of elevation means;
- (ii) attaching leg sections to the frame;
- (iii) increasing the height of the elevation means;
- (iv) adding further leg sections;
- (v) attaching a lower edge of a screen to a lower rear piece of the frame;
- (vi) raising an upper edge of the screen to adjacent an upper front section of the frame; and
- (vii) attaching the upper edge of the screen to the upper front section of the frame.

The method may comprise providing the elevation means in the form of a jack.

The method may comprise providing the screen in the form of a film. The method may comprise removing a roll of screen film from a protective cylindrical casing. The method may comprise laying the screen upon a dust-free protective sheet.

The method may comprise placing the lower edge of the screen between jaws of a first retention member and may further comprise securing the screen in position using a fixing means passing through the retention member and the screen and a locking means arranged to lock the fixing means being arranged to secure the locking means in position. The method may comprise providing the fixing means in the form of a bolt and the locking means in the form of a nut.

The method may comprise attaching tensioning means to the retention member adjacent at least some of the fixing means.

The method may comprise attaching the tensioning means to the lower rear piece of the frame.

The method may comprise attaching a second retention member to an upper edge of the film screen, typically in the same manner as the first retention member is attached to the lower edge. The method may comprise attaching tensioning means to the second retention member. The method may comprise providing the tensioning members in the form of ratchet straps.

The method may comprise attaching a rope to the second retention member and passing the rope over the upper frame and using the rope in step (vii) to raise the screen.

The method may include tensioning each of the tensioning means such that the screen is flat and substantially wrinkle free.

The method may include depending a projector from the upper frame.

The method may include placing a pigmented reflective board between the screen and a front edge of the frame. The method may comprise reflecting light emitted by the projector from the board onto the screen.

The method may comprise forming the frame form a truss work.

According to a third aspect of the present invention there is provided a projection apparatus constructed according to the second aspect of the present invention.

#### BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

The invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

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FIG. 1 is a schematic representation of a first embodiment of a projection apparatus according to at least an aspect of the present invention;

FIG. 2 is a side view of a the projection apparatus of FIG. 1 showing a pigmented reflective member in first and second positions;

FIG. 2a is a schematic representation of an alternative projection arrangement, suitable for use with the apparatus of FIGS. 1 and 2;

FIG. 3 is a schematic representation of a second embodiment of a projection apparatus according to at least an aspect of the present invention;

FIG. 4 is a perspective view of a screen clamping arrangement of FIGS. 1, 2 and 3; and

FIG. 5 is a schematic view of a projection apparatus being constructed according to the second aspect of the present invention.

#### DETAILED DESCRIPTION OF THE INVENTION

Referring now to FIGS. 1, 2 and 4, a projection apparatus 100 comprises a box frame 102 formed of trusses 104, a projector 106, a support frame 108, a screen 110 held within the support frame 108 and a grey pigmented reflective board 112.

The projector 106 depends from a front upper cross-piece truss 104a of the box frame 102. The board 112 lies below the projector 106 at the base of the box frame 102. The screen 110, is inclined at approximately 45° to the horizontal and the front edge of the screen 110 is proximate the front upper cross-piece truss 104a of the box frame 102 and the rear edge of the screen is proximate a stage 109 that lies to the rear of the box frame 102.

The screen 110 is typically a polymeric foil, which can have a partially reflective coating upon a front face of the foil. The screen 110 is retained within the box frame 102 by means of tensioning straps 114 attached to the box frame 102, at the top and bottom edges of the screen 110. At a free end of each of the tensioning straps 114 there is pair of clamp jaws 116 which have respective openings 118, 120 passing there-through. The faces of the jaws 116 are optionally coated with an abrasive 121, such as sandpaper, in order to enhance the grip of the jaws 116 upon the screen 110.

Edges of the screen 110 are placed between the jaws 116 and a bolt 122 is placed through the openings 118, 120 and passes through the screen 110. A nut 124 is threaded onto the bolt 122 and tightened to hold the screen 110 between the jaws 116. The tensioning straps 114 pass through the trusses 104 and are tightened using a friction locking buckle arrangement 128.

Each of the tensioning straps 114 can be tightened or loosened individually so as to allow an even tension to be applied over the whole surface of the screen 110 thereby reducing, and ideally eliminating, the formation of wrinkles upon the screen 110 which reduce the quality of an image projected upon the screen 110.

The reflective board 112 lies below the projector 106 adjacent to a lower front cross-piece truss 104b of the box frame 102. The projector 106 is directed such that light emitted by the projector 106 strikes the reflective board 112. The board 112 is inclined so that the light emitted by the projector 106 is reflected upwards from the board 112 onto the screen 110. The use of a grey, or otherwise coloured board 112 reduces the milky hue associated with light from the projector where there is no image to be projected.

A fraction of the projected light striking the screen 110 is reflected from the front surface of the screen 110 where is can

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be viewed by an audience. A presenter upon the stage 109 behind the screen 110 can also be viewed by the audience but does not interfere with the viewing of the image by the audience.

The board 112 is connected to a hinge arrangement 130 along a rear edge thereof. The hinge arrangement 130 allows the board 112 to be raised and lowered, typically by a hydraulic ramp 132 controlled by a computer 134, in order to compensate for the 'keystone' effect. Alternatively, the board 112 can be raised and lowered by the person pulling upon a string, or an electric motor to drive the board up and down.

The raising and lowering of the board 112 also allows for the audience's perception of the positional depth upon the stage of an element of a projected image to be altered by varying the height of the element of the image upon the screen 110. It is envisaged that the board 112 may comprise a number of individual sections each of which may be raised and lowered individually in order to allow the perceived depth of an individual element of an image to be varied independently of other elements of the image.

A non-reflective mask 136 in the shape of a prop 138, in this example a rock, is placed upon the board 112. The prop 138 is placed upon the stage 109, typically behind the screen 110. The mask 136 is placed such that the board 112 is obscured in a region corresponding to where the prop 138 is located with respect to the screen 110. This arrangement of mask 136 and prop 138 results in an image, or part of the image, projected upon the screen 110 apparently disappearing as the image, or part of the image, passes over prop 138 and reappearing once the image, or part of the image has passed over the prop 138 as the mask 136 prevents light being reflected onto the region of the screen 110 corresponding to the location of the prop 138. The mask 136 can be variable in size and shape, for example by means of a sliding panel that is moved into location and varied in size according to the size of the prop 138. This also allows for the depth perception of props to be varied as their apparent effect upon variable depth image elements, as discussed hereinbefore, can be varied appropriately, for example a given size of rock will obscure proportionately more of a distant image than the same rock will of a near image.

A light source 140 is mounted upon the box frame 102 and illuminates the prop 138 in order to reduce the effect of any residual light reflected from the board 112 onto the prop.

Referring now to FIG. 2a, an alternative projection arrangement 200, suitable for use with the apparatus of FIGS. 1 and 2 with an additional truss, comprises the projector 106 depending from a truss 202 forward of the screen 110, an inclined mirror 204 of variable inclination depending from a second truss 206 forward of projector 110. The projector 106 projects an image on to the mirror 204 such that the image is projected on to the reflective board 112 and on to the screen 110. The mirror 204 is typically arranged to be perpendicular to the board 112, and in embodiments where the board 112 has a variable angle of inclination the mirror 204 will usually be arranged to track, synchronously, with any variation in the angle of inclination of the board 112.

It will be appreciated that the term mirror is used herein to describe any reflective surface that reflects substantially all, typically in excess of 50% preferably in excess of 80%, light impinging upon it.

Referring now to FIG. 3, a projection apparatus 300 is substantially similar to that of FIGS. 1 and 2 accordingly identical parts to those of FIGS. 1 and 2 are accorded similar reference numerals in the three hundred series.

A projection screen 306 resides in front of the screen 310 adjacent the lower front cross-piece truss 304b. The projec-

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tion screen 306 is typically a liquid crystal display (LCD) screen or a television screen. The projection screen 306 projects an image upwards onto the front surface of the screen 310. The use of a projection screen 306 removes the 'keystone' effect associated with conventional projectors.

A mask 336 can be formed upon the screen by use of a computer 340 to control the projection screen 306 to black out the appropriate part of the projection screen 306 electronically. This removes the need for a physical mask to be produced. The computer 340 can be used to switch off areas of the projection screen 306 which do not contain part of an image to be projected, this reduces the milky white hue associated with such areas when using conventional projectors. Also, the use of a computer 340 to control the projection screen 306, together with image sizing in relation to image movement allows an image to be readily scaled and positioned upon the projection screen 306 to enhance an audience's perception of depth and movement of a projected image using known image processing techniques. Alternatively, the projection screen 306, or sections of the projection screen 306, can be raised and lowered under the control of the computer 340 in order to enhance the audience's perception of depth of the projected image.

Referring now to FIG. 5, a box truss framework 500 comprises a square upper truss work 502 and leg trusses 504. In constructing the framework 500 the upper truss work 502 rests upon a number of jacks 506. First sections 508 of the leg trusses 504 that extend at right angles to the upper truss work 502 are added at the corners of the upper truss work 502. The height of the jacks 506 is increased to allow additional sections 510 of the leg trusses 504 to be added until the desired height of the box truss framework 500 is achieved.

A cross-piece truss 512 is fixed to two of the leg trusses 504 such that it horizontally spans the gap therebetween at a height close to, and typically slightly below, the level of a stage floor 514. The leg trusses 504 spanned by the cross-piece truss 512 constitute the rear legs of the framework 500 and are located adjacent the front of the stage floor 514.

A dust-free protective plastic sheet 515 is laid across the width of the stage floor 514 in front of the rear legs of the framework 500. A roll of screen film 518 is removed from a protective cylindrical casing 520 and is unwound across the width of the stage floor 514. The film 518 is placed upon the sheet 515 in order to prevent damage to the surface from dust particles or other sharp protrusions.

A lower edge 522 of the film 518 is placed between jaws 524a,b of a retention member 526, each jaw 524a,b having opposed openings therethrough spaced at approximately 0.5 m intervals. Bolts 528 are placed through the openings, and through the film 518, and secured in position using respective nuts. Ratchet straps 532 are attached to the retention member 526 adjacent alternate bolts 528, having a spacing of approximately 1 m, and are then attached to the cross-piece truss 512.

A second retention member 534 is attached to an upper edge 536 of the film 518 in a similar manner to how the retention member 526 is attached to the lower edge 522. Ratchet straps 538 are attached to the second retention member 534.

A rope 540 is tied to the second retention member 534 and is passed over the upper truss work 502 opposite the cross-piece truss 512. The film is raised into position using the rope 540 and the ratchet straps 538 are attached to the upper truss work 502. Both sets of ratchet straps 532, 538 are tightened individually until the screen film is tensioned such that the film 518 is flat and, ideally, free from wrinkles.

A projector 542 is depended from the upper truss work 502 and a pigmented reflective board 544 is placed between the

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screen 518 and the front edge of the box truss framework 500 such that light emitted by the projector 542 is reflected from the board 544 onto the screen 518. The screen 518 reflects at least part of the light from a front surface thereof away from the stage and into an auditorium to be viewed by and audience.

In order to prevent the audience observing the projection apparatus both side and front drapes 546 are used to screen the apparatus from the audience.

The invention claimed is:

1. An image projection apparatus, comprising:

a projector, a frame, a light source and an at least partially transparent screen;

the frame being arranged to retain the screen under tension, such that the tension of the screen can be varied at a plurality of positions along at least one edge of said screen such that the screen is substantially wrinkle free; the light source arranged to illuminate at least part of the apparatus;

the screen inclined at an angle with respect to a plane of emission of light from the projector and the screen having a front surface arranged such that light emitted from the projector is reflected therefrom; and

the projector being arranged to project an image such that light forming the image impinges upon the screen such that a virtual image is created from light reflected from the screen, the virtual image appearing to be located behind the screen, wherein the screen is foil and the frame comprises first and second retention members each arranged to sandwich an edge region of the screen therebetween, the first and second retention members comprising respective openings therethrough arranged to collocate with respective openings in the screen, wherein the openings are arranged to receive a fixing means so as to clamp the screen between the first and second retention members, and wherein at least one of the first and second retention members is attached to tensioning straps.

2. The apparatus of claim 1, wherein the screen is attached to the frame at the screen's upper edge, lower edge, or both.

3. The apparatus of claim 1, wherein the tensioning straps are attached to a truss arrangement or a fixed mounting point located in a permanent structure such as a wall, floor or ceiling and are adjustable such that the tension of the screen within the truss arrangement can be varied about the periphery of the screen.

4. The apparatus of claim 3, wherein the retention members are substantially parallel to truss members comprising the truss arrangements.

5. The apparatus of claim 1, wherein the screen is inclined at approximately 45° to the plane of emission of light from the projector.

6. The apparatus of claim 1, wherein the light source is located to the rear of the screen, along a top edge of the frame, along either side of a stage, or some combination thereof.

7. An image projection apparatus, comprising:

a projector, a frame or fixed mounting points, and an at least partially transparent screen;

the frame or fixed mounting points being arranged to retain the screen under tension, such that the screen is inclined at an angle with respect to a plane of emission of light from the projector;

the screen having a front surface arranged such that light emitted from the projector is reflected therefrom; and the projector being arranged to project an image such that light forming the image impinges upon the screen such that a virtual image is created from light reflected from

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the screen, the virtual image appearing to be located behind the screen, and wherein the frame comprises first and second retention members arranged to sandwich an edge region of the screen therebetween, and wherein a plurality of fixing means pass through the first retention member and through the screen and clamp the screen between the first and second retention members, and optionally locking means is provided adapted to lock the fixing means;

wherein the screen is a polymeric transparent foil that is held taught and substantially wrinkle-free by the retention members, the retention members having generally parallel faces which clamp an edge region of the foil between them, and wherein individually variable foil tensioning mechanisms are provided at spaced apart locations around the periphery of the foil to enable the foil to have tensioning force independently varied at the said spaced apart locations around the periphery of the foil, and wherein the first and second retention members are connected to one or more flexible tensioning means, which extend from the frame or fixed mounting points to the foil-gripping members, the foil, flexible tensioning means and the frame or fixed mounting points lying in a common inclined plane, with the tension on the foil being applied in the plane of the flexible tensioning means, and the foil, the tensioning mechanisms comprising straps and ratchet strap tensioners, or straps and a friction-locking buckle arrangement.

8. The apparatus according to claim 7, wherein respective locking means are provided for the fixing means.

9. The apparatus according to claim 8, wherein the locking means is provided in the form of nuts, to lock the fixing means in position, the fixing means extending through the retention members and the screen.

10. The apparatus according to claim 7, wherein the first and second retention members comprise a plurality of respective openings, with the fixing means extending through the openings.

11. The apparatus according to claim 7, wherein an abrasive surface is provided on at least one of the retention members to increase the grip between the retention member and the screen, thereby reducing the likelihood of the screen slipping when held by the retention member.

12. The apparatus according to claim 11, wherein the abrasive surface comprises sandpaper.

13. The apparatus according to claim 7, wherein the screen is a foil.

14. An image projection apparatus, comprising:

a projector, a frame or fixed mounting points, and an at least partially transparent screen;

the frame or fixed mounting points being arranged to retain the screen under tension, such that the screen is inclined at an angle with respect to a plane of emission of light from the projector;

the screen having a front surface arranged such that light emitted from the projector is reflected therefrom; and

the projector being arranged to project an image such that light forming the image impinges upon the screen such that a virtual image is created from light reflected from the screen, the virtual image appearing to be located behind the screen, and wherein the frame comprises first and second retention members arranged to sandwich an edge region of the screen therebetween, the first and second retention members being connected to one or more flexible tensioning means, which extend from the frame or fixed mounting points, the foil, flexible tensioning means and the frame or fixed mounting points lying

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in a common inclined plane, with the tension on the foil being applied in the plane of the flexible tensioning means and the foil, and wherein a plurality of fixing means pass through the first retention member and through the screen and clamp the screen between the first and second retention members, optionally locking means is provided adapted to lock the fixing means, and the first and second retention members comprise respective openings therethrough arranged to collocate with openings in respective jaws of clamping members attached to tensioning straps.

15. The apparatus according to claim 14, wherein the screen comprises a partially reflective layer upon the front surface and is inclined at approximately 45° to the plane of emission of light from the projector.

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16. The apparatus according to claim 14, wherein the screen is attached to the frame at the screen's upper edge, lower edge, or both.

17. The apparatus according to claim 14, wherein the tensioning straps are attached to a truss arrangement or a fixed mounting point located in a permanent structure such as a wall, floor or ceiling and are adjustable such that the tension of the screen within the truss arrangement can be varied about the periphery of the screen.

18. The apparatus according to claim 17, wherein the retention members are substantially parallel to truss members comprising the truss arrangement.

\* \* \* \* \*

# **EXHIBIT C**





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Patent #: [7883212](#) Issue Dt: 02/08/2011 Application #: 10599553 Filing Dt: 09/30/2006  
 Publication #: [20070201004](#) Pub Dt: 08/30/2007  
 Inventors: Ian O'Connell, James Rock  
 Title: PROJECTION APPARATUS AND METHOD FOR PEPPER'S GHOST ILLUSION

**Assignment: 1**

Reel/Frame: [018419/0258](#) Recorded: 10/21/2006 Pages: 5  
 Conveyance: ASSIGNMENT OF ASSIGNORS INTEREST (SEE DOCUMENT FOR DETAILS).  
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Reel/Frame: [031615/0800](#) Recorded: 11/11/2013 Pages: 12  
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