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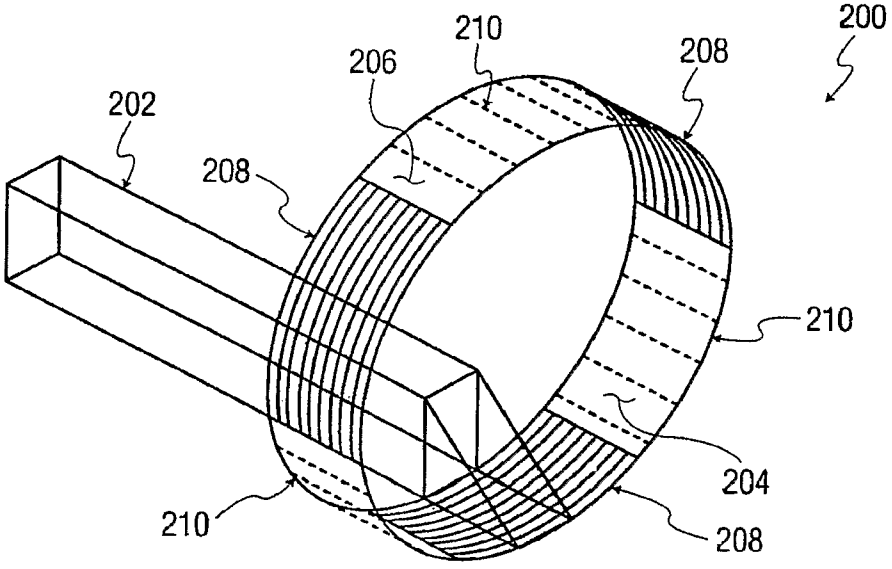
(54) **Title:** 2D/3D PROJECTOR WITH ROTATING TRANSLUCENT CYLINDER FOR ALTERNATING LIGHT POLARISATION



(57) **Abstract:** A 3D image projector having a translucent rotatable hollow cylinder, the hollow cylinder having differently polarized sections, and the projector being capable of passing a light beam generally orthogonally through a wall of the hollow cylinder is disclosed.

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2D/3D PROJECTOR WITH ROTATING TRANSLUCENT CYLINDER FOR ALTERNATING LIGHT POLARISATION

Field of the Invention

The invention relates generally to the generation of 3D images. More specifically, the invention relates to the conversion of 2D images into 3D images and projecting the 3D images.

Background of the Invention

It is well known that a projected image may be enhanced with an appearance of depth by converting the projected image into a so-called 3D image. This is generally accomplished by optically polarizing the images which are to be viewed by a viewer's left eye differently than the images which are to be viewed by a viewer's right eye. The 3D effect is perceived by the viewer when the viewer views the polarized images through the use of polarized filter lenses, commonly configured as '3D viewing glasses' with a polarized filter for use with the left eye of the viewer and a differently polarized filter for use with the right eye of the viewer. When the 3D viewing glasses are used to view the 3D images, the left eye of the viewer sees only the light polarized appropriately for passage through the polarized filter associated with the left eye and the right eye of the viewer sees only the light polarized appropriately for passage through the polarized filter associated with the right eye of the viewer. The above described method of displaying 3D images is known as passive 3D viewing where the projector alternates the left eye information with the right eye information at double the typical frame rate and a screen/filter/polarizing blocker in front of the projector's lenses alternates the polarization of the projected image in such a way that the image of each eye passes through the corresponding polarizing filter of the pair of passive stereo glasses discussed above.

An alternative to passive 3D viewing is active 3D viewing where each viewer wears glasses with LCD light shutters which work in synchronization with the projector so that when the projector displays the left eye image, the right eye shutter of the active stereo eyewear is closed, and vice versa. One problem with current systems for providing 3D images is that the projectionist must attach and configure an external special device to the standard projector, a costly and time consuming requirement which also leads to technical

failure. Further, when the projectionist again desires to project only a 2D image, the special device must be manually removed or turned off. In addition, having such a device attached to the projector parallel to the projection lens surface introduces a risk that light will reflect back to the imagers from which the light originates, often causing lower picture quality in color productions and undesirable contrast ratio change in black&white productions.

Another problem with current 2D/3D projectors is that the color gamut achieved by typical single projector systems is not as extensive as intended by the director of the film. Referring now to Figure 1 (Prior Art), a typical three color prism 100 is shown. Prism 100 is typically used with a three-chip digital micromirror device projector. As shown, a light beam 102 enters prism 100, and in reaction to known optical coating methods, is selectively reflected or transmitted depending on the wavelength of the light. Further, known total internal reflection techniques, such as providing a small air gap between prism 100 components, may be used to control the reflection of the divided components of light beam 100. After having been separated into three color components, each light beam 102 color component is directed to and selectively reflected out of prism 100 by a digital micromirror device. Particularly, digital micromirror device 104 reflects a blue color component of light beam 102, digital micromirror device 106 reflects a green color component of light beam 102, and digital micromirror device 108 reflects a red color component of light beam 102. Each digital micromirror device 104, 106, 108 may be individually controlled in a known manner to produced a combined color image which is projected from prism 100.

While there are many advanced methods of displaying 3D images, room for improvement remains.

Summary of the Invention

The present invention is directed to a 3D image projector having a translucent rotatable hollow cylinder, the hollow cylinder having more than one differently polarized sections, and the projector being capable of passing a light beam generally orthogonally through a wall of the hollow cylinder.

Brief Description of the Drawings

Figure 1 is an orthogonal schematic illustration of a prism used for separating a light beam into three color components according to prior art;

Figure 2 is an oblique schematic illustration of a polarization drum according to the present invention; and

Figure 3 is an orthogonal schematic illustration of a 3D projector according to the present invention.

Detailed Description of the Invention

Referring now to Figure 2 in the drawings, a polarizing drum (or hollow cylinder) according to a first embodiment of the present invention is illustrated. Polarizing drum 200 is a rotatable drum-like structure (or hollow cylinder) formed of translucent materials. Drum 200 is shown as a generally cylindrical band of material located in close proximity or next to a directional light transmission device (or light pipe) 202 for passing light through drum 200 by directing light generally orthogonal to an interior surface 204 of the drum 200 such that light passes through the translucent material and exits the drum 200 through an exterior surface 206 of the drum 200 (through a wall of the drum). As shown, the drum is divided into radially alternating P-polarization sections 208 (or clockwise circular polarization sections) and S-polarization sections 210 (or counter-clockwise circular polarization sections). In operation, a 2D image may be converted to a 3D image by transmitting the 2D image through the directional light transmission device 202 and subsequently through the polarization drum 200 while drum 200 is rotated about its central axis. The drum 200 is rotated at a controlled speed so as to appropriately polarize each frame of images as either P-polarization or S-polarization by passing the image through sections 208, 210, respectively.

Referring now to Figure 3 in the drawings, a 3D projector according to the present invention is illustrated. Projector 300 comprises a light source 302 having a reflector 304, a directional light transmission device 306 similar to device 202, a polarizing drum 308 similar to drum 200, relay optics 310, a prism 312 similar to prism 100, and digital micromirror devices 314, 316, 318, similar to digital micromirror devices 104, 106, 108, respectively. In operation, light source 302 emits a light beam 320 into directional light transmission device 306 which then directs the light through polarizing drum 308 as polarizing drum 308 rotates about its central axis. The light beam 320 then travels through relay optics 310 which direct

the light beam 320 into prism 312. Prism 312 divides the light beam 320 into separate color components and directs the color components of the light beam 320 onto digital micromirror devices 314, 316, 318, which are associated with the colors blue, green, and red, respectively. As described above, the color components of light beam 320 are then subsequently directed out of prism 312 by digital micromirror devices 314, 316, 318. The 3D image is perceived by a viewer of the projected image when the viewer wears polarized filter glasses (not shown) which allow only one of the P and S polarized portions of light through the glasses to each eye of the viewer. The projector should present approximately twice the number of frames per second in 3D mode as opposed to a normal 2D mode since each eye will only see every other frame. Alternatively, the projector can be used as a 2D projector by projecting image data containing only frames to be viewed by both eyes of the viewer simultaneously, by the viewer not wearing polarized filter glasses, and by optionally not rotating the polarization drum 306. The rotation and/or attachment of the polarizing drum to the projector 300 may optionally be controlled by a software instruction and no further mechanical interaction by a user of the projector 300.

An aspect of the invention also includes the method of converting 2D images into 3D images, wherein a 2D image projected through the translucent polarized hollow cylinder (i.e. drum) as the hollow cylinder is rotated such that the projected 2D images are projected generally orthogonally through a wall of the hollow cylinder. The method includes the 2D images being projected alternatingly through P-polarized and S-polarized sections of the hollow cylinder. Alternatively, the projected 2D images can be projected alternatingly through clockwise circular polarized and counter-clockwise circular polarized sections of the hollow cylinder. After projecting the 2D images through the hollow cylinder, the images are projected into a prism configured to split a light beam into three primary color components and direct each of the primary color components to separate digital micromirror devices. Further, the step of selectively preventing rotation of the hollow cylinder in response to a software instruction can be included. In the method, the rotatable hollow cylinder comprises a translucent wall having differently polarized sections.

It is to be understood that although six separate polarization portions are shown in Figure 2, a smaller or greater number of different separate polarization portions can be utilized. Further, although the polarization sections are generally designed to not be color

filters, embodiments where the polarization sections are also color filters is considered be an aspect of the invention.

The foregoing illustrates only some of the possibilities for practicing the invention. Many other embodiments are possible within the scope and spirit of the invention. It is, therefore, intended that the foregoing description be regarded as illustrative rather than limiting, and that the scope of the invention is given by the appended claims together with their full range of equivalents.

CLAIMS

1. A projector, comprising:

a rotatable hollow cylinder having more than one differently polarized sections;

wherein a light beam is capable of being passed generally orthogonally through a wall of the hollow cylinder.

2. The projector according to claim 1, wherein the light beam is passed through the wall of the hollow cylinder as the hollow cylinder is rotated about a central axis of the hollow cylinder.

3. The projector according to claim 1, wherein the differently polarized sections are polarized as either P-polarized or S-polarized.

4. The projector according to claim 3, wherein each P-polarized section is generally radially bounded by S-polarized sections and each S-polarized section is generally radially bounded by P-polarized sections.

5. The projector according to claim 1, wherein the differently polarized sections are polarized as either clockwise circular polarized or counter-clockwise circular polarized.

6. The projector according to claim 5, wherein each clockwise circular polarized section is generally radially bounded by counter-clockwise circular polarized sections and each counter-clockwise circular polarized section is generally radially bounded by clockwise circular polarized sections.

7. The projector according to claim 1, further comprising:

a prism configured to split a light beam into three primary color components and direct each of the primary color components to separate digital micromirror devices.

8. The projector according to claim 1, further comprising:

a software instruction capable of selectively preventing rotation of the hollow cylinder.

9. The projector according to claim 1, further comprising:

a software instruction capable of selectively attaching the hollow cylinder to the projector and detaching the hollow cylinder from the projector.

10. The projector according to claim 1, wherein the projector is a 3D projector and the polarizing sections are translucent and not color filters.

11. A method of converting 2D images into 3D images, comprising the step of:

projecting a 2D image through a translucent polarized hollow cylinder as the hollow cylinder is rotated.

12. The method according to claim 11, wherein the projected 2D images are projected generally orthogonally through a wall of the hollow cylinder.

13. The method according to claim 11, wherein the projected 2D images are projected alternatingly through P-polarized and S-polarized sections of the hollow cylinder.

14. The method according to claim 11, wherein the projected 2D images are projected alternatingly through clockwise circular polarized and counter-clockwise circular polarized sections of the hollow cylinder.

15. The method according to claim 11, further comprising the step of:

after projecting the 2D images through the hollow cylinder, projecting the images into a prism configured to split a light beam into three primary color components and direct each of the primary color components to separate digital micromirror devices.

16. The method according to claim 11, further comprising the step of:

selectively preventing rotation of the hollow cylinder in response to a software instruction.

17. A drum for a 3D projector, the drum comprising:

a translucent wall having differently polarized sections.

18. The drum according to claim 17, wherein the differently polarized sections are polarized as either P-polarized or S-polarized.

19. The drum according to claim 18, wherein each P-polarized section is generally radially bounded by S-polarized sections and each S-polarized section is generally radially bounded by P-polarized sections.

20. The drum according to claim 17, wherein the differently polarized sections are polarized as either clockwise circular polarized or counter-clockwise circular polarized.

21. The drum according to claim 20, wherein each clockwise circular polarized section is generally radially bounded by counter-clockwise circular polarized sections and each counter-clockwise circular polarized section is generally radially bounded by clockwise circular polarized sections.

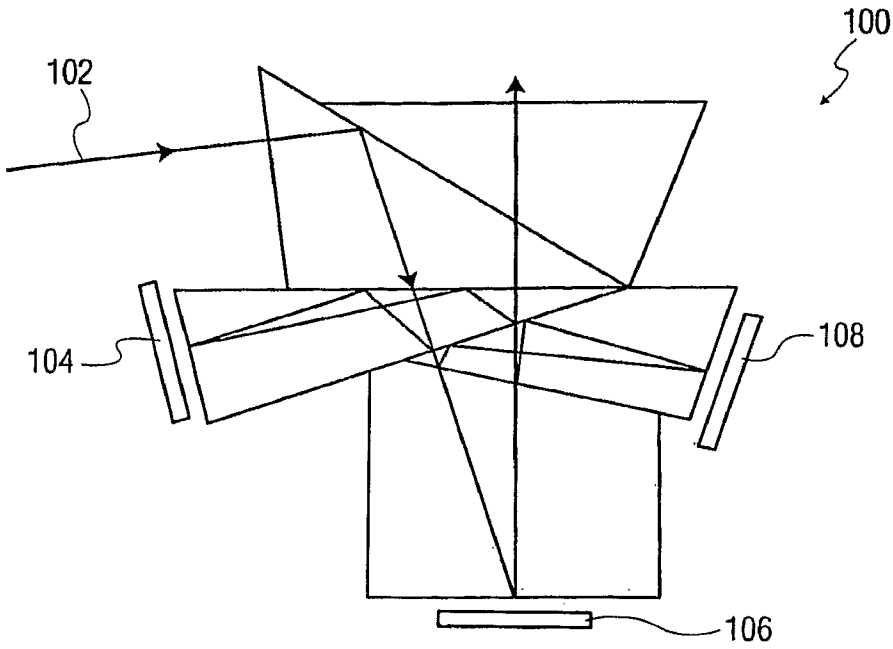

FIG. 1
PRIOR ART

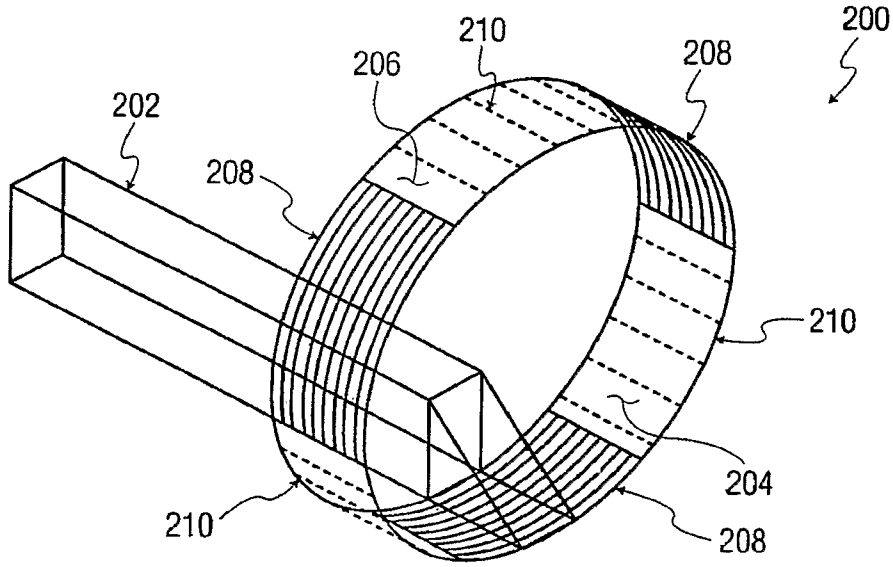

FIG. 2

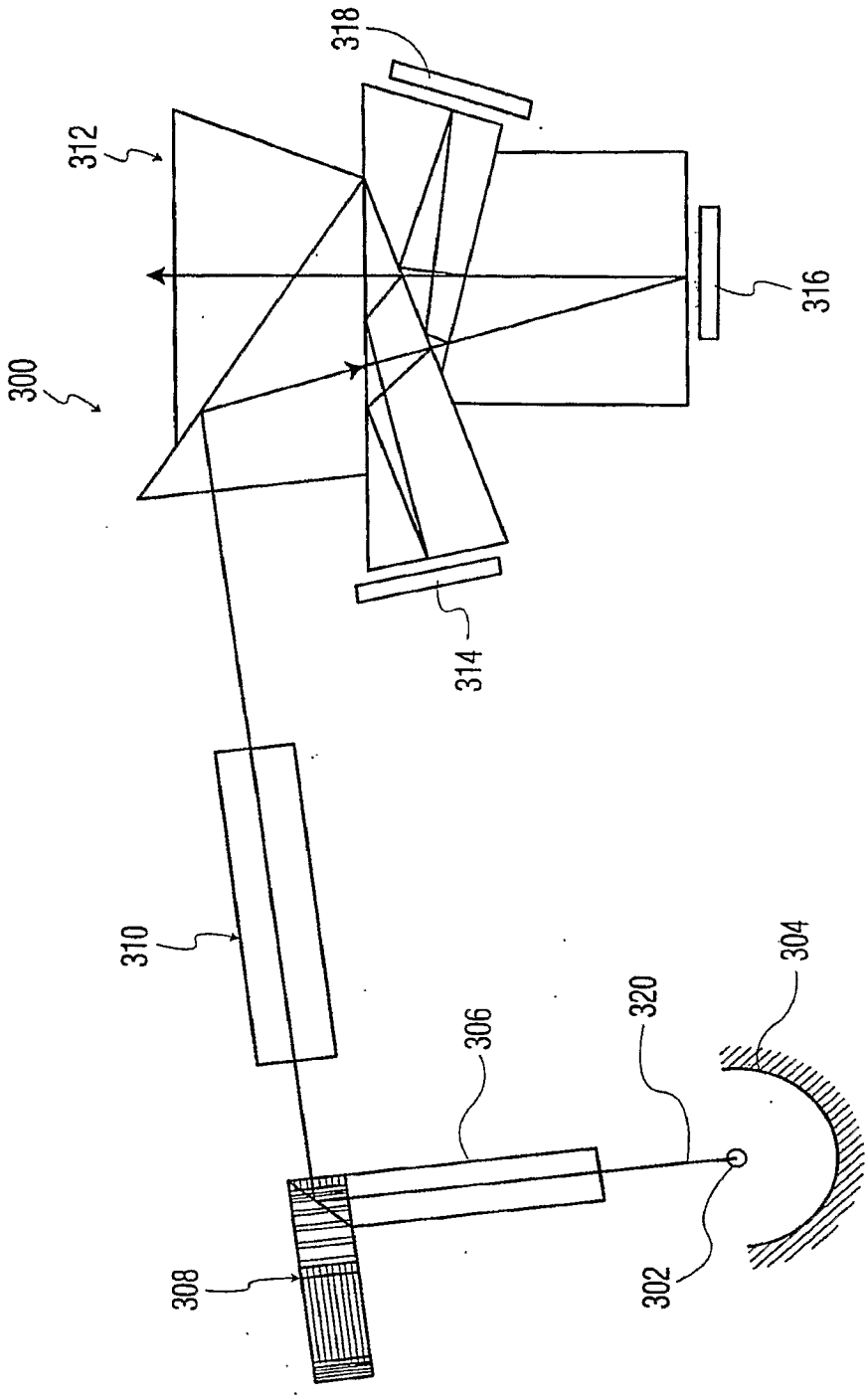

FIG. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2006/048038

A. CLASSIFICATION OF SUBJECT MATTER
INV. G02B5/30 H04N13/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G02B H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 2006/039068 A1 (TOKITA TOSHIAKI [JP] ET AL) 23 February 2006 (2006-02-23) abstract; figures 1-3,5,7,27,31,33 paragraphs [0001] - [0065], [0081] - [0093], [0126] - [0129]	1-6, 10-14, 17-21 7-9,15, 16
Y	US 2006/044525 A1 (LEE KYE-HOON [KR] ET AL) 2 March 2006 (2006-03-02) abstract; figure 6 paragraphs [0003] - [0008], [0045] - [0048]	7,15
Y	US 2001/024268 A1 (FIELDING RAYMOND GORDON [GB] ET AL) 27 September 2001 (2001-09-27) abstract; figures 6-9 paragraphs [0002] - [0005]	7,15

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 June 2007	29/06/2007

Name and mailing address of the ISA/	Authorized officer
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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2006/048038

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 10 268230 A (SHARP KK) 9 October 1998 (1998-10-09) abstract	8,9,16
A	US 5 903 304 A (DETER CHRISTHARD [DE]) 11 May 1999 (1999-05-11) the whole document	1-21

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2006/048038

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2006039068 A1	23-02-2006	NONE	
US 2006044525 A1	02-03-2006	NONE	
US 2001024268 A1	27-09-2001	NONE	
JP 10268230 A	09-10-1998	JP 3434163 B2	04-08-2003
US 5903304 A	11-05-1999	DE 19537356 C1	05-12-1996
		WO 9714074 A1	17-04-1997
		EP 0796453 A1	24-09-1997
		JP 10510637 T	13-10-1998