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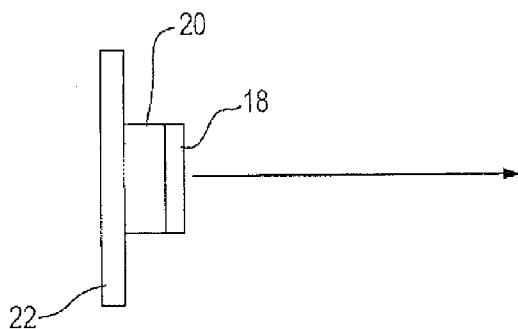


FIG. 2

(57) Abstract: A phosphor-based lamp includes a phosphor material and an excitation source, which may be a laser or an LED, or both. Preferably, the lamp includes a recycling collar to reflect and recycle high angle light to increase brightness. Preferably, when the excitation source is a laser, a beam splitter redirects the laser beam to direct the laser beam through the recycling collar aperture onto the phosphor material. Light emitted by the phosphor material which exits the aperture passes through the beam splitter as the output of the lamp. Alternatively, lenses are used to redirect the laser beam around the recycling collar towards the phosphor material. Preferably, a plurality of excitation lasers are disposed around the recycling collar and aimed either to direct their outputs onto the phosphor material or toward an opposing wall, where the outputs are reflected onto the phosphor material.

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## INTERNATIONAL SEARCH REPORT

International application No.

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<b>A. CLASSIFICATION OF SUBJECT MATTER</b> IPC(8) - F21V 7/04 (2013.01) USPC - 362/84 According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b> Minimum documentation searched (classification system followed by classification symbols) IPC(8) - F21V 7/00, 04, 06, 08; G02B 5/08, 10, 27/00, 18 (2013.01) USPC -362/84, 235, 236, 237, 241, 247, 257, 259, 296.01, 295.05, 296.08, 317, 341, 347, 350 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched CPC - F21V 7/00, 04, 06, 08; G02B 5/08, 10, 27/00, 18 (2013.01) Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) PatBase, Google Patents, Google Scholar		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X		4, 5, 21
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Y	US 2010/0045937 A1 (LI) 25 February 2010 (25.02.2010) entire document	1-3, 6-16
Y	US 2009/0040465 A1 (CONNER et al) 12 February 2009 (12.02.2009) entire document	6-10, 16
Y	US 2006/0227302 A1 (HARBERS et al) 12 October 2006 (12.10.2006) entire document	8
Y	WO 01/27962 A2 (DOLAN et al) 19 April 2001 (19.04.2001) entire document	11
Y	US 2009/0296368 A1 (RAMER) 03 December 2009 (03.12.2009) entire document	12-15
Y	US 2010/0301728 A1 (HELBING et al) 02 December 2010 (02.12.2010) entire document	1-3
A	US 2008/0094835 A1 (MARRA et al) 24 April 2008 (24.04.2008) entire document	1-16, 21
A	US 2010/0296144 A1 (BORCHERS et al) 25 November 2010 (25.11.2010), figure 1C, 2A; para. [0013], [0034], 0040].	1-16, 21
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/>		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "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 15 January 2014		Date of mailing of the international search report <b>06 FEB 2014</b>
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201		Authorized officer: Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2013/046492

**Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1.  Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
  
2.  Claims Nos.:  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
  
3.  Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

See extra sheet

1.  As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2.  As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3.  As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4.  No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:  
1-16, 21

**Remark on Protest**

- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2013/046492

Continuation of Box III.

This application contains claims directed to more than one species of the generic invention. These species are deemed to lack unity of invention because they are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for more than one species to be examined, the appropriate additional examination fees must be paid. The species are as follows:

Species I) an LED coated with a phosphor material, figure 4

Species II) a fluorescent cell containing a fluorescent material in a liquid carrier, a pump for circulating said liquid carrier and a heat sink for cooling said liquid carrier, figure 24

Species III) a projector system having a light source, a color wheel for receiving light output from said light source, relay lenses for receiving the output of the color wheel, a projection engine for receiving the output of the relay lenses, and output projection lenses; wherein said color wheel is coated with a phosphorous material, figure 7

The claims are deemed to correspond to the species listed above in the following manner:

Species I) figure 4; claims 1-3

Species II) figure 24; claims 17-20

Species III) figure 7; claim 22

The following claims are generic: claims 4-16 and 21.

The species listed above do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, the species lack the same or corresponding special technical features for the following reasons:

Species I) figure 4; have the special technical feature of an LED coated with a phosphor material. This special technical feature is not present in species II or III.

Species II) figure 24; have the special technical feature of a fluorescent cell containing a fluorescent material in a liquid carrier, a pump for circulating said liquid carrier and a heat sink for cooling said liquid carrier. This special technical feature is not present in species I or III.

Species III) figure 7; have the special technical feature of a projector system having a light source, a color wheel for receiving light output from said light source, relay lenses for receiving the output of the color wheel, a projection engine for receiving the output of the relay lenses, and output projection lenses; wherein said color wheel is coated with a phosphorous material. This special technical feature is not present in species I or II.

Species I, II and III lack unity of invention because even though the inventions of these groups require the technical feature of phosphor-based lamp having a coating of phosphor material and an excitation laser having an output directed towards said phosphor material., this technical feature is not a special technical feature as it does not make a contribution over the prior art in view of US 2010/0296144 A1 (BORCHERS et al) 25 November 2010 (25.11.2010), figure 1C, 2A; para. [0013], [0034], 0040].

Since none of the special technical features of the Species I, II and III inventions is found in more than one of the inventions, unity of invention is lacking.