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Declaration under Rule 4.17:

— *of inventorship (Rule 4.17(iv))*

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(54) Title: RIPPLED MIXERS FOR UNIFORMITY AND COLOR MIXING

(57) Abstract: Various embodiments described herein comprise mixers comprising a light pipe having input and output ends and a central region therebetween. An optical path extends in a longitudinal direction from the input end through the central region to the output end. The central region of the light pipe comprises one or more rippled reflective sidewalls having a plurality of elongate ridges and valleys and sloping surfaces therebetween. Light from the input end propagating along the optical path reflects from the sloping surfaces and is redirected at a different azimuthal direction toward the output end thereby mixing the light at the output end. Illuminance and/or color mixing can therefore be provided.



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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US06/29274

A. CLASSIFICATION OF SUBJECT MATTER

IPC: G02B 5/136(2006.01),27/10(2006.01)

USPC: 359/546,618

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)

U.S. : 359/546,618

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 practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6,080,467 (WEBER et al.) 27 June 2000 (27.06.2001), figures 11-12, abstract, col. 4, lines 58-67. col. 5, lines 8-27.	107-109
A	US 5,363,470 (WORTMAN) 8 November 1994 (08.11.1994), abstract	107-109
A	US 2001/0012429 (WACH et al.) 9 August 2001 (09.08.2001), abstract	107-109



Further documents are listed in the continuation of Box C.



See patent family annex.

Special categories of cited documents:	
"A" document defining the general state of the art which is not considered to be of particular relevance	"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
"E" earlier application or patent published on or after the international filing date	"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
"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)	"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
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

29 May 2008 (29.05.2008)

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Box I Observations where certain claims were found unsearchable (Continuation of Item 1 of first sheet)

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

1. ☐ Claim Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claim 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. ☐ Claim Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of Item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
Please See Continuation 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 an additional fee, this Authority did not invite payment of any additional fee.
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.: 107-109

Remark on Protest☐
☐

The additional search fees were accompanied by the applicant's protest.

No protest accompanied the payment of additional search fees.

BOX II. OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING

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: This application contains claims directed to the following patentably distinct species:

Species A (mixer coupled with light source) of Figures 1 (pg. 18, paragraph 0157) and 2 (pg. 21, paragraph 0161),
Species B (rippled sidewall w/ plurality of ridges and valleys) of Figures 3 (pg. 6, paragraph 0024) and 4 (pg. 6, paragraph 0025, and pg. 22, paragraph 0164),
Species C (ridges and valleys configurations) of Figure 7 (pg. 7, paragraphs 0038-0039),
Species D (mixer coupled directly w/ light source) of Figures 8 (pg. 8, paragraphs 0040-0042), 9 (pg. 8, paragraph 0043), and 13 (pg. 9, paragraphs 0057-0059),
Species E (rippled square mixer) of Figures 11 (pg. 33, paragraph 0208) and 20B (pg. 11, paragraph 0081),
Species F (adding rippled sidewalls w/ smooth mixer having oval-shape) of Figure 14 (pg. 9, paragraphs 0060-0063),
Species G (rippled mixer w/ first portion oval and second portion pentagonal) of Figure 15 (pg. 9, paragraph 0064),
Species H (mixers w/ different input and output face areas) of Figures 16 (pg. 10, paragraphs 0065-0067) and 19 (pgs. 10-11, paragraphs 0077-0079),
Species I (angle-to-area converting mixer coupled directly w/ light source) of Figures 17 (pg. 10, paragraphs 0068-0074) and 18 (pg. 10, paragraphs 0075-0076),
Species J (rippled mixer narrowing toward center) of Figures 20A (pg. 11, paragraph 0080) and 20C (pg. 11, paragraph 0082),
Species K (rippled mixer w/ ridges and valleys decreasing in height from input to output face) of Figure 21 (pg. 11, paragraphs 0083-0086),
Species L (variants of rippled sidewalls) of Figures 22 (pgs. 11-12, paragraphs 0087-0095), 23 (pg. 12, paragraphs 0096-0098), 24 (pg. 12, paragraph 0099, and pg. 56, paragraph 0290), 40 (pg. 16, paragraph 0136) and 41 (pg. 16, paragraphs 0137-0142),
Species M (rippled mixer w/ ridges and valleys angled w/ respect to length of mixer) of Figures 25 (pgs. 12-13, paragraphs 0100-0104) and 26 (pg. 13, paragraphs 0105-0106),
Species N (rippled mixer w/ ridges and valleys curving w/ respect to length of mixer) of Figure 27 (pg. 13, paragraph 0107),
Species O (rippled angle-to-area converting mixer w/ solid and optically transmissive material) of Figures 28 (pg. 13, paragraph 0108),
Species P (rippled mixer coupled with projection lens) of Figures 29 (pg. 13, paragraphs 0109-0110) and 30 (pgs. 13-14, paragraphs 0111-0115),
Species Q (fiber illuminator) of Figure 31 (pg. 14, paragraph 0116),
Species R (mixer w/ bends) of Figure 32 (pg. 14, paragraphs 0117-0122),
Species S (rippled mixer w/ non-imaging optical element) of Figure 33 (pg. 15, paragraphs 0123-0125),
Species T (curved mixer) of Figure 34 (pg. 15, paragraphs 0126-0127),
Species U (mixer tapered from input to output face) of Figure 35 (pg. 15, paragraph 0128),
Species V (mixer w/ solid rod) of Figures 36 (pg. 15, paragraphs 0129-0130) and 37 (pg. 15, paragraph 0131),
Species W (mixer w/ optically transmissive outer layer over core) of Figure 38 (pg. 15, paragraphs 0132-0133),
Species X (mixer w/ core and cladding) of Figure 39 (pgs. 15-16, paragraphs 0134-0135),
Species Y (system w/ mixers and transfer optics) of Figure 42 (pg. 77, paragraph 0359),
Species Z (system w/ mixer coupled w/ diffuser) of Figure 43 (pg. 16, paragraph 0144), and
Species AA (mixer array) of Figure 44 (pg. 16, paragraphs 0145-0146).

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: the species are independent or distinct because each species has a different design and separate function.