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**Iwasaki et al.**

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(54) **IMAGING LENS AND IMAGING APPARATUS EQUIPPED WITH THE IMAGING LENS**

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(63) Continuation of application No. PCT/JP2013/007642, filed on Dec. 26, 2013.

(30) **Foreign Application Priority Data**

Mar. 25, 2013 (JP) ..... 2013-061647

(51) **Int. Cl.**
***G02B 13/18*** (2006.01)
***G02B 9/64*** (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ..... ***G02B 13/0045*** (2013.01); ***G02B 5/005*** (2013.01); ***G02B 9/34*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC .. G02B 13/0045; G02B 9/60; G02B 27/0025; G02B 13/18; G02B 5/005; G02B 13/002; G02B 13/004; G02B 9/34
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,488,788 A 12/1984 Fujioka
7,274,515 B2 9/2007 Noda
(Continued)

FOREIGN PATENT DOCUMENTS

JP 58-156916 9/1983
JP 64-057221 3/1989
(Continued)

OTHER PUBLICATIONS

"International Preliminary Report on Patentability" of PCT/JP2013/007642, mailed on Sep. 8, 2014, with partial English translation thereof, p. 1-p. 6, in which seven of the listed references (JP2008-176185, JP64-057221, JP10-020193, JP58-156916, U.S. Pat. No. 4,488,788, JP03-265809 and JP2004-029474) were cited.
(Continued)

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(57) **ABSTRACT**

An imaging lens is constituted essentially by four or more lenses, including, in order from the object side to the image side: a first lens having a positive refractive power; a second lens having a negative refractive power; and a plurality of other lenses. The conditional formulae below are satisfied.

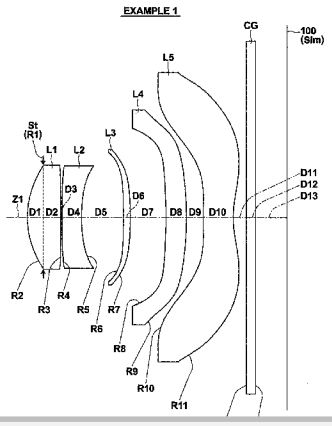
$$0.8<TL/f<1.0 \quad (1)$$

$$1.0<f/fl<3.0 \quad (2)$$

$$2.03 \text{ mm}<f<5.16 \text{ mm} \quad (3)$$

$$1.0 \text{ mm}<fl<3.0 \text{ mm} \quad (4)$$

wherein f is the focal length of the entire lens system, fl is the focal length of the first lens, TL is the distance along the optical axis from the surface of the first lens toward the object side to the paraxial focal point
(Continued)



position at the image side in the case that the portion corresponding to back focus is an air converted length.

**17 Claims, 10 Drawing Sheets**

(51) **Int. Cl.**

| | |
|---|---|
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| ***G02B 9/34*** | (2006.01) |
| ***G02B 9/60*** | (2006.01) |
| ***G02B 9/62*** | (2006.01) |
| ***G02B 5/00*** | (2006.01) |
| ***G02B 27/00*** | (2006.01) |

(52) **U.S. Cl.**
CPC ..... ***G02B 9/60*** (2013.01); ***G02B 9/62*** (2013.01); ***G02B 13/004*** (2013.01); ***G02B 27/0025*** (2013.01); *G02B 13/002* (2013.01); *G02B 13/18* (2013.01)

(58) **Field of Classification Search**
USPC ..... 359/714, 715, 739, 740, 763, 764, 773
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

| | | | | |
|---|---|---|---|---|
| 9,261,671 | B2 * | 2/2016 | Noda | G02B 13/0045 |
| 2008/0180813 | A1 * | 7/2008 | Taniyama | G02B 13/006 359/715 |
| 2010/0103533 | A1 * | 4/2010 | Taniyama | G02B 13/004 359/715 |
| 2010/0309367 | A1 * | 12/2010 | Iba | G02B 9/34 348/345 |
| 2011/0115962 | A1 * | 5/2011 | Chen | G02B 9/34 348/335 |
| 2011/0249348 | A1 * | 10/2011 | Kubota | G02B 13/0045 359/764 |
| 2012/0044403 | A1 * | 2/2012 | Tang | G02B 13/18 348/340 |
| 2012/0044583 | A1 * | 2/2012 | Ise | G02B 13/004 359/715 |
| 2012/0057071 | A1 | 3/2012 | Yoneyama et al. | |
| 2012/0086848 | A1 * | 4/2012 | Tsai | G02B 13/004 348/340 |
| 2012/0147249 | A1 * | 6/2012 | Okano | G02B 13/004 348/340 |
| 2014/0192423 | A1 * | 7/2014 | Kondo | G02B 13/18 359/714 |

FOREIGN PATENT DOCUMENTS

| | | |
|---|---|---|
| JP | 03-265809 | 11/1991 |
| JP | 10-020193 | 1/1998 |
| JP | 2004-029474 | 1/2004 |
| JP | 2008-176185 | 7/2008 |
| JP | 2012-058407 | 3/2012 |
| JP | 2013-106289 | 5/2013 |
| KR | 2010-0062480 | 6/2010 |

OTHER PUBLICATIONS

"Office Action of Japan Counterpart Application", issued on Dec. 1, 2015, p. 1-p. 3, with a partial English translation thereof.

* cited by examiner

FIG.1

EXAMPLE 1

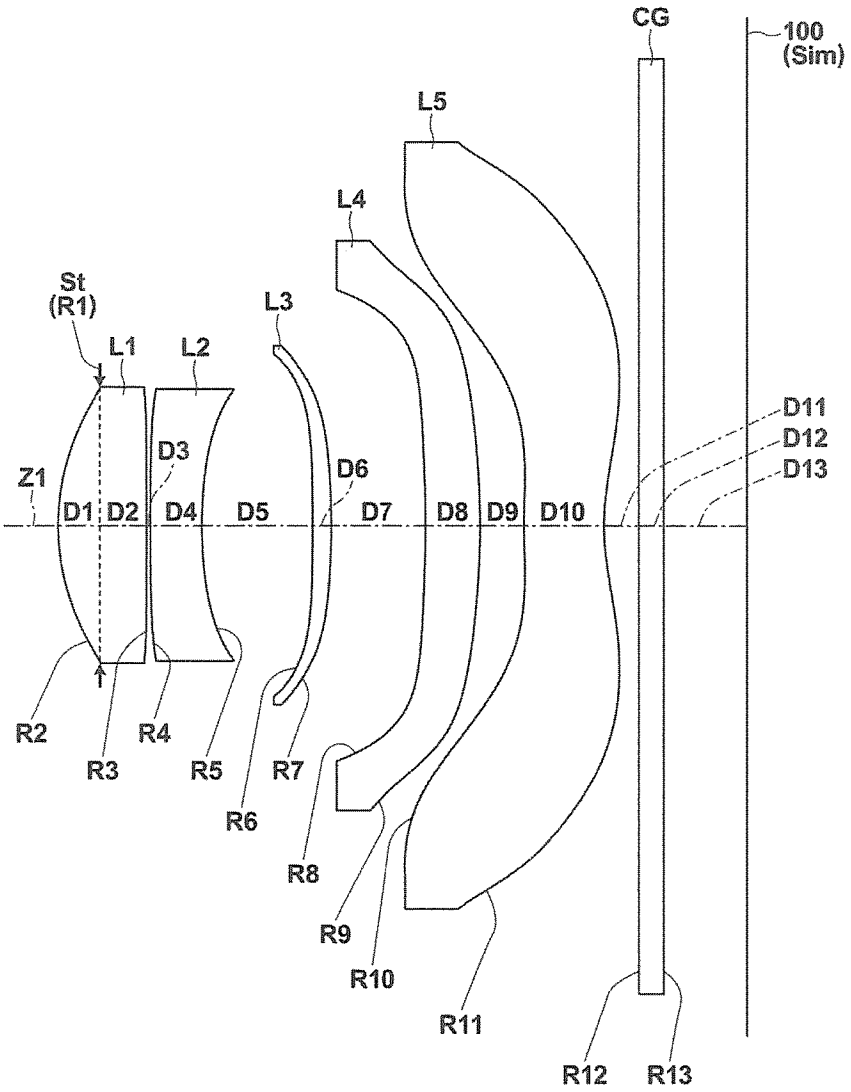


FIG.2

EXAMPLE 2

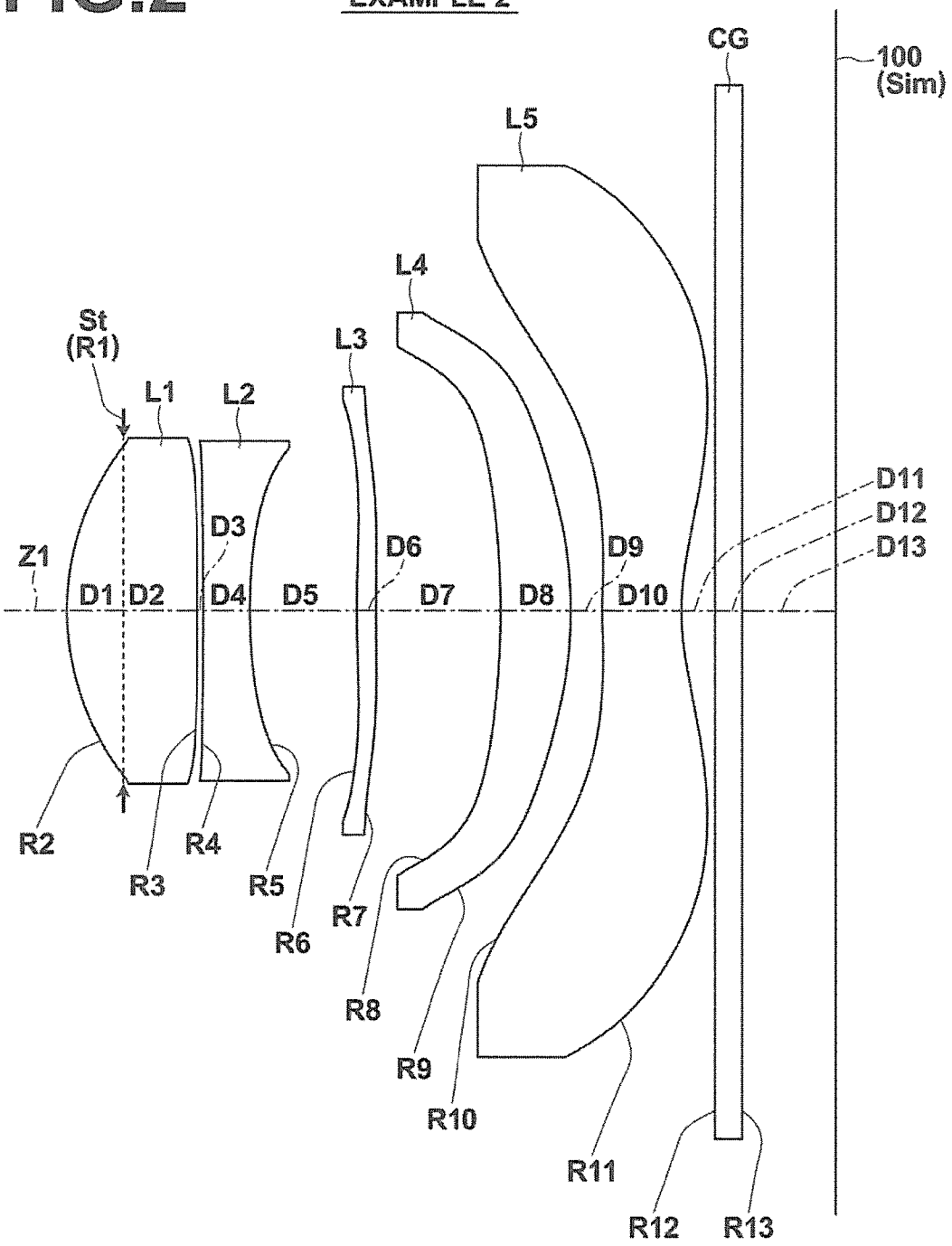
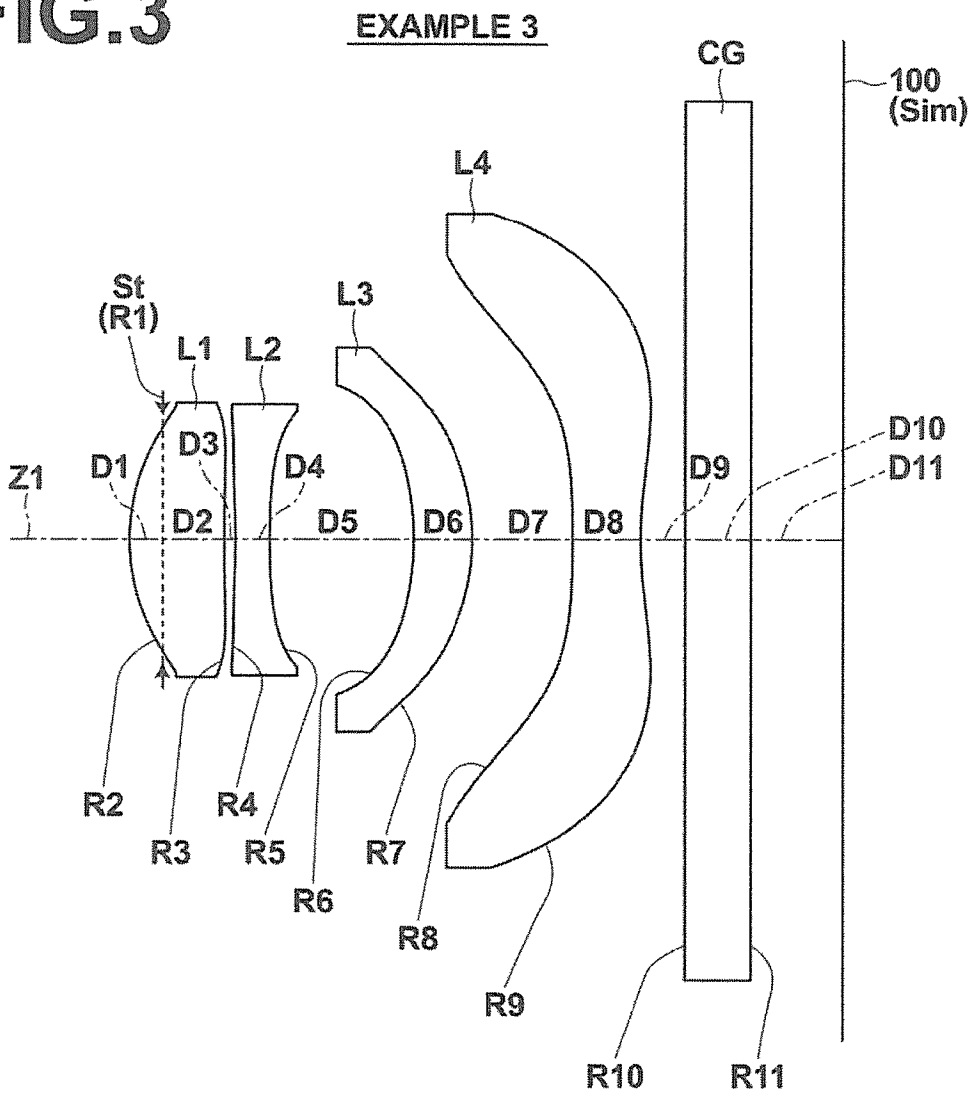


FIG.3



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