

(12) United States Patent Dror et al.

(54) MINIATURE TELEPHOTO LENS ASSEMBLY

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U.S.C. 154(b) by 0 days.

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Related U.S. Application Data

- (63) Continuation-in-part of application No. 15/170,472, filed on Jun. 1, 2016, now Pat. No. 9,568,712, which is a continuation of application No. 14/932,319, filed on Nov. 4, 2015, now Pat. No. 9,402,032, which is a continuation of application No. 14/367,924, filed as application No. PCT/IB2014/062465 on Jun. 20, 2014, now abandoned.
- (60) Provisional application No. 61/842,987, filed on Jul. 4, 2013.
- (51) Int. Cl. G02B 9/60 (2006.01)G02B 13/18 (2006.01)G02B 13/00 (2006.01)G02B 13/02 (2006.01)G02B 27/00 (2006.01)G02B 1/04 (2006.01)G02B 27/64 (2006.01)H04N 101/00 (2006.01)

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> (2013.01); G02B 27/0025 (2013.01); G02B **27/646** (2013.01); *H04N 2101/00* (2013.01); Y10T 29/4913 (2015.01)

Field of Classification Search

CPC .. G02B 13/0045; G02B 9/60; G02B 27/0025; G02B 5/005; G02B 13/02; G02B 1/041; G02B 13/002; G02B 9/00; G02B 27/646; H04N 2101/00; Y10T 29/4913

USPC 359/714, 739, 740, 763, 764

See application file for complete search history.

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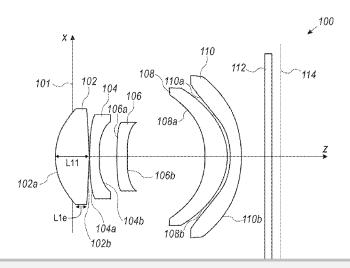
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ABSTRACT

An optical lens assembly includes five lens elements and provides a TTL/EFL<1.0. In an embodiment, the focal length of the first lens element f1<TTL/2, an air gap between first and second lens elements is smaller than half the second lens element thickness, an air gap between the third and fourth lens elements is greater than TTL/5 and an air gap between the fourth and fifth lens elements is smaller than about 1.5 times the fifth lens element thickness. All lens elements may be aspheric.

5 Claims, 6 Drawing Sheets





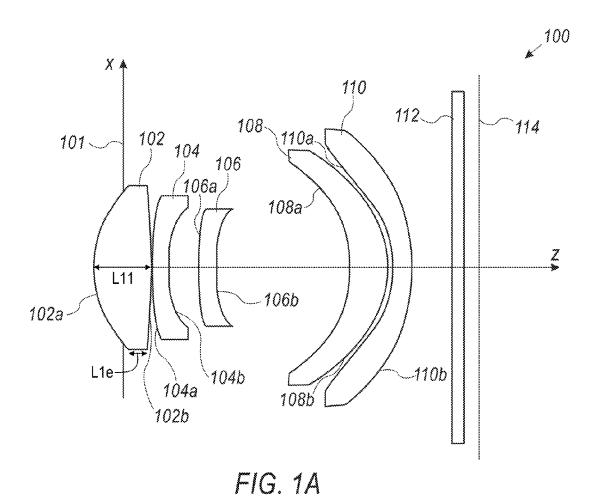
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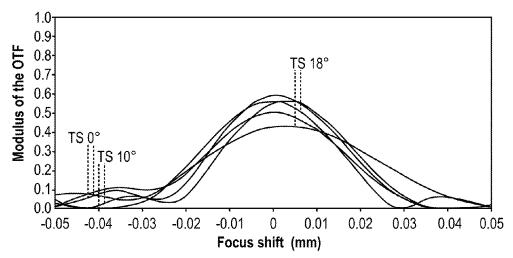
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Polychromatic Diffraction Through Focus MTF

Angle 6/2/2013

Data for 0.4350 to $0.6560 \mu m$.

Spatial Frequency: 180.0000 cycles/mm.

FIG. 1B

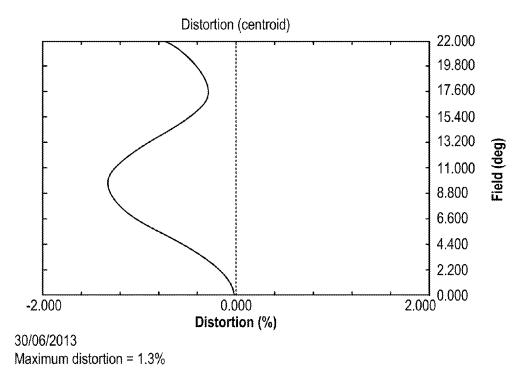


FIG. 1C



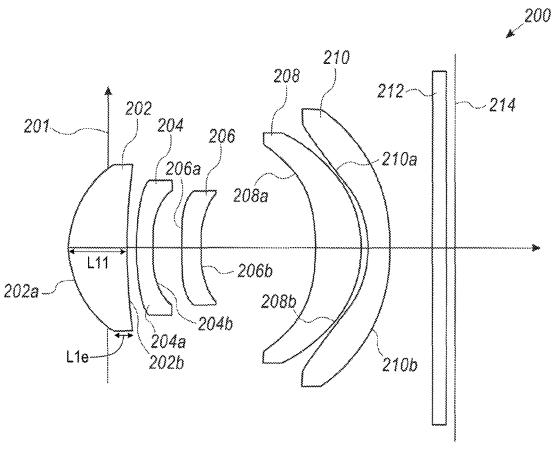


FIG. 2A

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