



US010962745B2

(12) **United States Patent**
Dror et al.

(10) **Patent No.:** **US 10,962,745 B2**
(45) **Date of Patent:** **Mar. 30, 2021**

(54) **MINIATURE TELEPHOTO LENS ASSEMBLY**

(71) Applicant: **Corephotonics Ltd.**, Tel-Aviv (IL)

(72) Inventors: **Michael Dror**, Nes Ziona (IL);
Ephraim Goldenberg, Ashdod (IL);
Gal Shabtay, Tel Aviv (IL)

(73) Assignee: **Corephotonics Ltd**, Tel Aviv (IL)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **16/914,313**

(22) Filed: **Jun. 27, 2020**

(65) **Prior Publication Data**

US 2020/0326513 A1 Oct. 15, 2020

Related U.S. Application Data

(63) Continuation of application No. 16/829,804, filed on Mar. 25, 2020, which is a continuation of application (Continued)

(51) **Int. Cl.**

G02B 13/00 (2006.01)
G02B 13/02 (2006.01)
G02B 9/60 (2006.01)
G02B 27/00 (2006.01)
G02B 1/04 (2006.01)

(Continued)

(52) **U.S. Cl.**

CPC **G02B 13/0045** (2013.01); **G02B 1/041** (2013.01); **G02B 9/60** (2013.01); **G02B 13/02** (2013.01); **G02B 27/0025** (2013.01); **G02B 27/646** (2013.01); **G02B 5/005** (2013.01); **G02B 9/00** (2013.01); **G02B 13/002** (2013.01);

(Continued)

(58) **Field of Classification Search**

CPC G02B 13/001; G02B 13/002;
G02B 13/0045; G02B 9/60; G02B 3/04
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,106,752 A 2/1938 Land
2,354,503 A 7/1944 Cox
(Continued)

FOREIGN PATENT DOCUMENTS

CN 102193162 A 9/2011
CN 102147519 B 1/2013
(Continued)

OTHER PUBLICATIONS

A compact and cost effective design for cell phone zoom lens, Chang et al., Sep. 2007, 8 pages.
(Continued)

Primary Examiner — Robert E. Tallman

(74) *Attorney, Agent, or Firm* — Menachem Nathan;
Nathan & Associates

(57) **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 $f_1 < TTL/2$, 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.

17 Claims, 6 Drawing Sheets

