US005381236A

United States Patent [19]

Morgan

[11] Patent Number: 5,381,236

[45] Date of Patent: Jan. 10, 1995

[54] **OPTICAL SENSOR FOR IMAGING AN OBJECT**

[75] Inventor: **Colin G. Morgan**, Horspath, United Kingdom

[73] Assignee: **Oxford Sensor Technology Limited**, Summertown, United Kingdom

[21] Appl. No.: **104,084**

[22] PCT Filed: **Feb. 6, 1992**

[86] PCT No.: **PCT/GB92/00221**

§ 371 Date: **Aug. 10, 1993**

§ 102(e) Date: **Aug. 10, 1993**

[22] Filed: **Aug. 10, 1993**

[30] **Foreign Application Priority Data**

Feb. 12, 1991 [GB] United Kingdom 9102903

[51] **Int. Cl.**[6] **G01B 11/24**

[52] **U.S. Cl.** **356/376**; 250/201.7; 250/561

[58] **Field of Search** 356/376, 375, 4; 250/561, 201.7

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,629,324	12/1986	Stern .	
4,640,620	2/1987	Schmidt .	
5,151,609	9/1992	Nakagawa et al.	356/376

OTHER PUBLICATIONS

Applied Optics, vol. 26, No. 12, (1987), pp. 2416–2420; T. R. Corle E.A.: "Distance Measurements By Differential Confocal Optical Ranging".

Optical Engineering, vol. 29, No. 12, (1990), pp. 1439–1444; Jian Li E.A.: "Improved Fourier Transform Profilometry For The Automatic Measurement Of Three-Dimensional Object Shapes".

Technische Rundschau, vol. 79, No. 41, (1987), pp. 94–98; E. Senn: "Dreidimensionale Multipunktmessung Mit Strukturiertem Licht".

Applied Optics, vol. 29, No. 10, (1990), pp. 1474–1476; J. Dirickx E.A.: "Automatic Calibration Method For Phase Shift Shadow Moire Interferometry".

IEEE Transactions on Pattern Analysis and Machine, vol. 11, No. 11, (1989), pp. 1225–1228; Makoto Matsuki E.A.: "A Real-Time Sectional Image Measuring System Using Time Sequentially Coded Grating Method".

IBM Technical Disclosure Bulletin, vol. 16, No. 2, (1973), pp. 433–444; J. R. Malin: "Optical Micrometer".

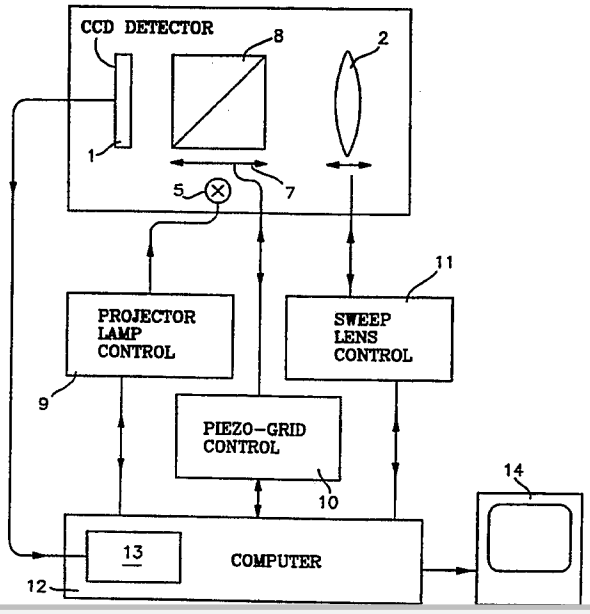
Primary Examiner—F. L. Evans

Attorney, Agent, or Firm—Webb Ziesenheim Bruening Logsdon Orkin & Hanson

[57] **ABSTRACT**

The sensor comprises a structured light source (**5, 6, 7**) which is adjustable so as to interchange the positions of contrasting areas of the pattern it provides, a detector (**1**) which comprises an array of detector elements having dimensions matched to the pattern produced by the light source, an optical system (**2, 8**) for projecting a primary image of the light source pattern onto an object (**3**) that is to be sensed and for forming a secondary image on the detector (**1**) of the primary image thus formed on the object (**3**), positioning means (**4**) for moving at least part (**2**) of the optical system so as to vary the focussing of the primary image on the object (**3**) and processing means (**12**) for analyzing signals produced by the detector (**1**) in conjunction with information on the adjustment of the optical system (**2, 8**). The optical arrangement is 'confocal' so that, when the primary image is in focus on the object (**3**), the secondary image on the detector (**1**) is also in focus. The processing means (**12**) is arranged to analyse the images received by the detector (**1**) with the contrasting areas thereof in the interchanged positions to determine which parts of the images are in focus and hence determine the range of the corresponding parts of the object being viewed.

16 Claims, 5 Drawing Sheets



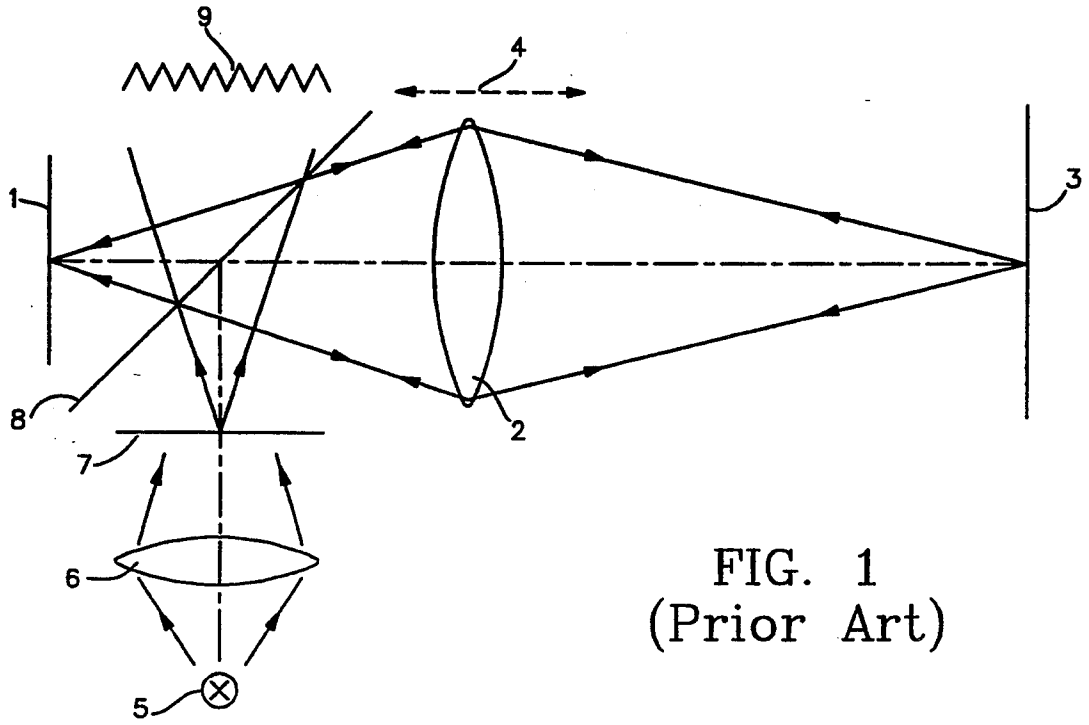


FIG. 1
(Prior Art)

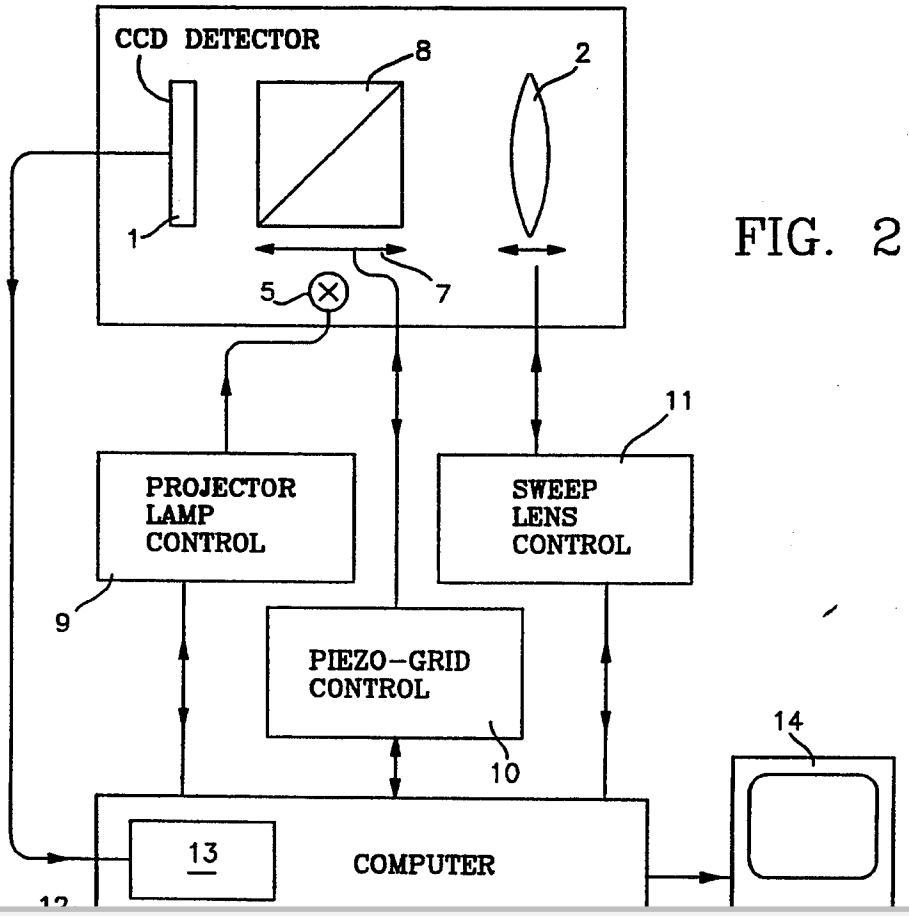


FIG. 2

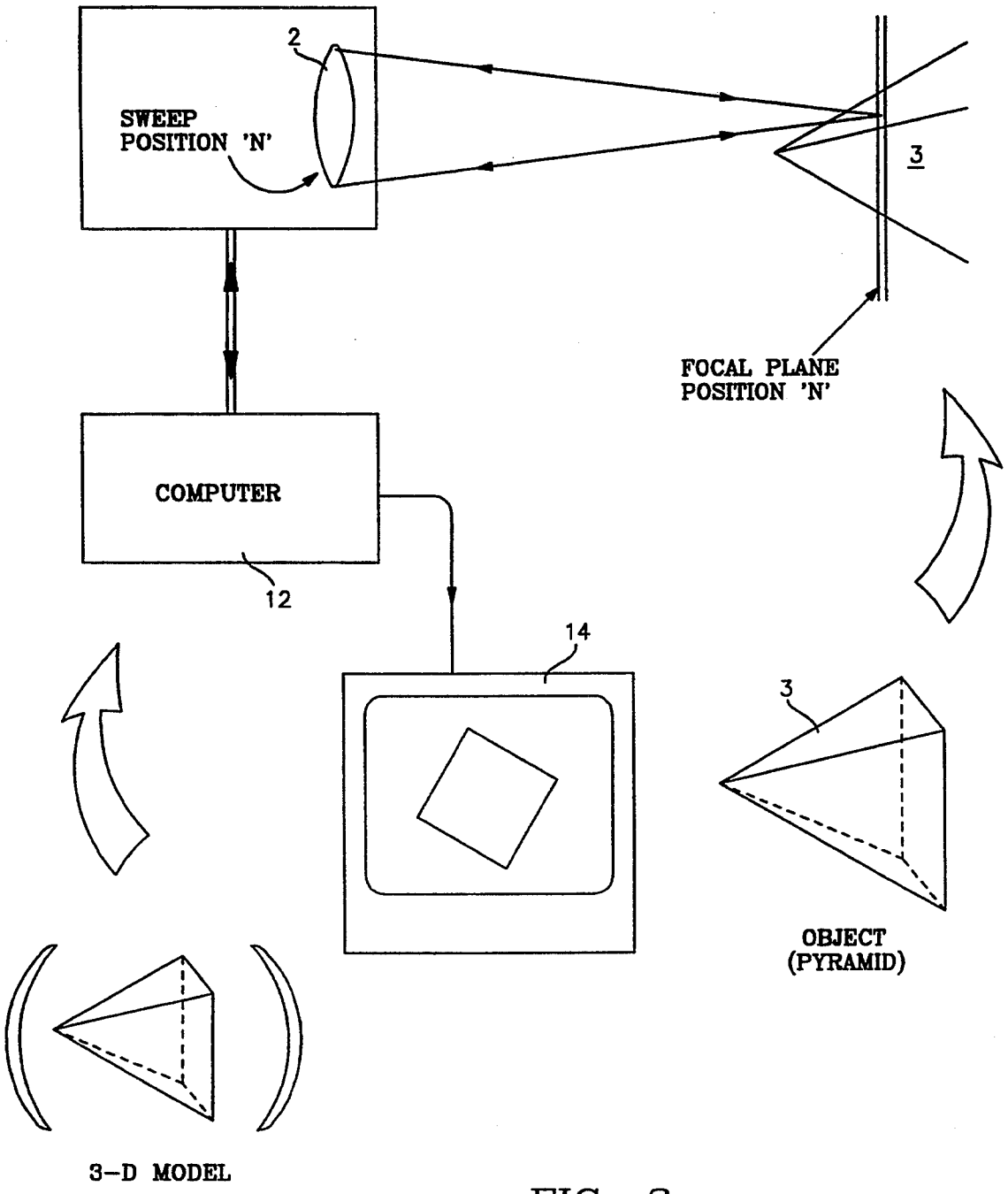


FIG. 3

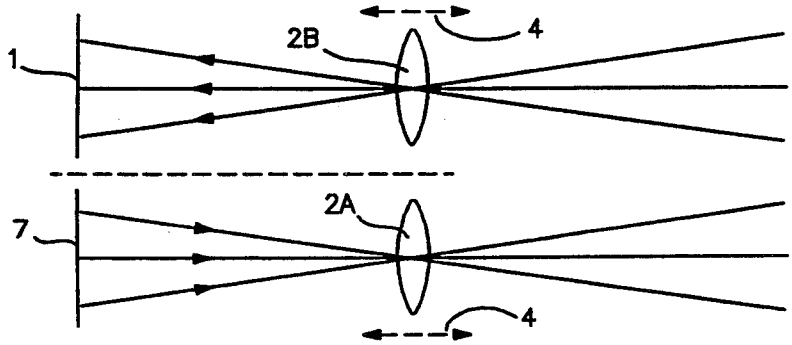


FIG. 4

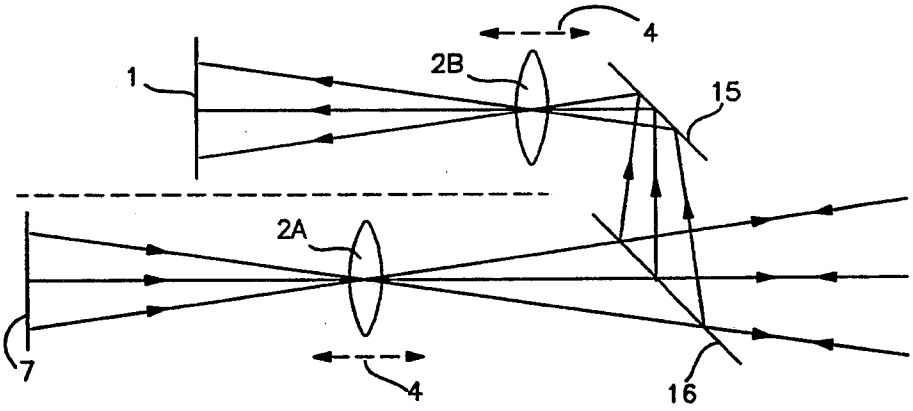


FIG. 5

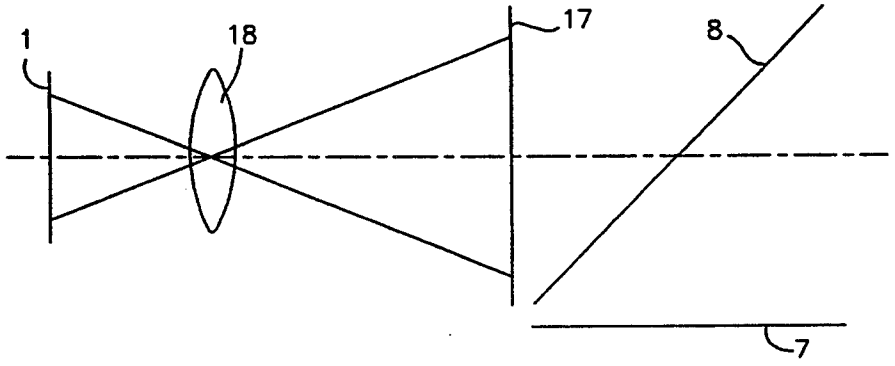


FIG. 6

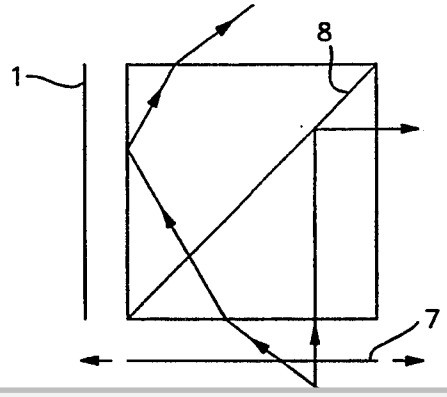


FIG. 7

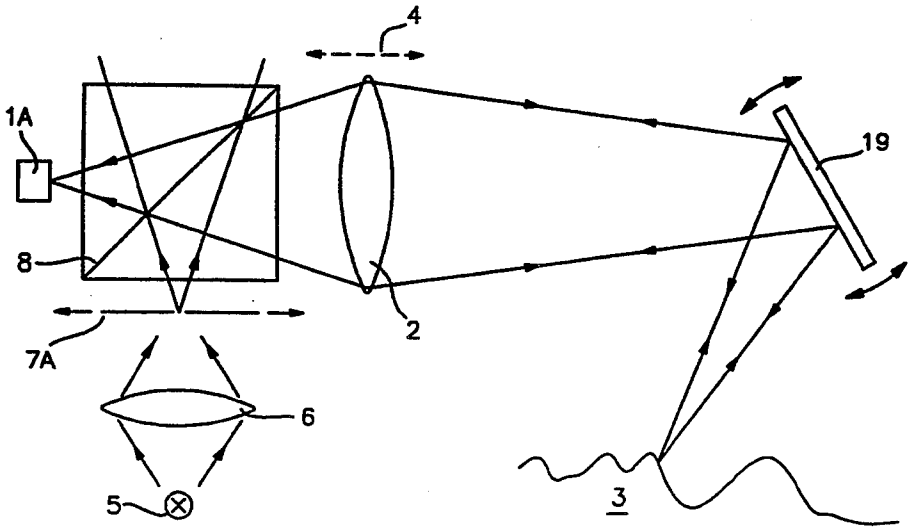


FIG. 8A

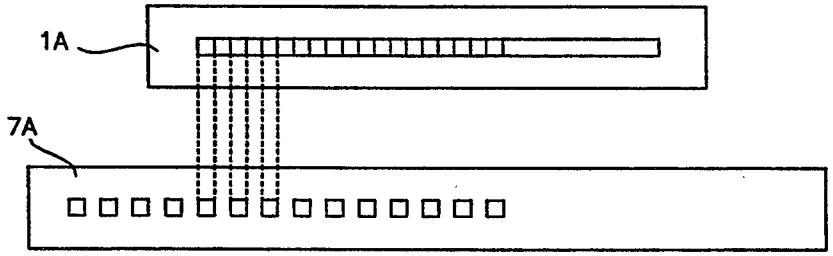


FIG. 8B

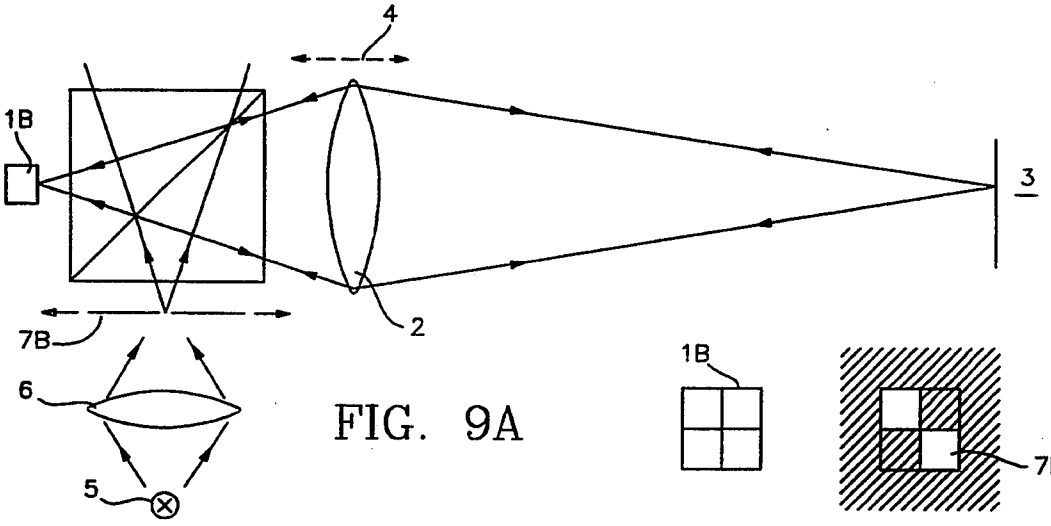


FIG. 9A

FIG. 9B

DOCKET ALARM

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts

Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research

With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips

Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS
Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS
Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS
Sync your system to PACER to automate legal marketing.