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- with international search report (Art. 21(3))
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))

[Continued on next page]

- (54) **Title:** COMPACT OPTICAL SYSTEM FOR SUBSTANTIALLY SIMULTANEOUS MONITORING OF SAMPLES IN A SAMPLE ARRAY

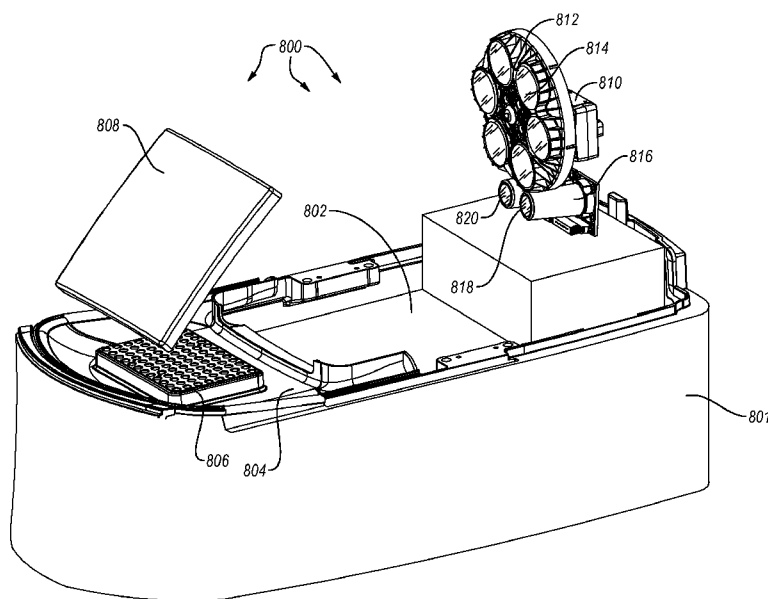


FIG. 8A

(57) **Abstract:** Optical systems and apparatuses configured for enabling substantially simultaneous observation of a plurality of points in an array from a common reference point. Without the optical systems and apparatuses disclosed herein, less than all of the plurality of points can be observed substantially simultaneously from the common reference point.



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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 14/21317

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - G02B 21/04 (2014.01)

CPC - G02B 21/04

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)

IPC(8) - G02B 21/04 (2014.01)

CPC - G02B 21/04

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
 IPC(8)- G01J 3/42, G02B 21/04 (2014.01) CPC- B01L3/50*, G01J 3/42, G01J 3/443, G01J 3/45, G02B21/04, G02B21/361, H04B10/11
 USPC-356/440,441,445,450,451; 359/364,368,398; 422/549,551,552,553

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
 Patbase, Proquest Dialog, Google Patents, Google Scholar Search terms used: assay, microscope, optics, mirror, aspheric, parabola, simultaneous, equal ray lengths, same ray lengths, dual curved bi-conic, surface profile equation, sag of surface parallel to the optical axis, conic constant, view, sample, wells, tubes, PCR reaction, camera,

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X -- Y	US 5,724,189 A (FERRANTE) 03 March 1998 (03.03.1998) Fig 1; Fig 2; col 5, ln 30-50; col 6, ln 10-60	1, 2, 4-9, 19 ----- 10, 11
X	US 5,856,888 A (ROSS et al.) 05 January 1999 (05.01.1999) Fig 3; col 2, ln 5-15; col 4, ln 28- col 5, ln 5	1-3, 17, 18
X --- Y	US 5,567,294 A (DOVICH I et al.) 22 October 1996 (22.10.1996) Fig 1; Fig 2; abstract; col 3, ln 33-55; col 5, ln 30-55	1, 15, 17, 18 ----- 16
X --- A	US 7,760,361 B2 (FURUSAWA) 20 July 2010 (20.07.2010) Fig 3, col 5, ln 17-35	1, 12 ----- 13, 14
Y	"Testing Aspheres" (PRUSS et al) Optic and Photonics News April 2008 (04.2008) pg 24-29.	10, 11
Y	US 2010/0055770 A1 (Kopp) 04 March 2010 (04.03.2010) para [0003], [0007], [0008]	16
A	US 3,927,944 A (IWASHASHI et al.) 23 December 1975 (23.12.1975) col 1, ln 8-32, col 2, ln 4- 17, col 2, ln 39-41, col 3, ln 34-63	1-19
A	US 2012/0045756 A1 (ROTHMANN et al.) 23 February 2012 (23.02.2012) para [0006], [0023], [0029], [0119].	1-19

☐ Further documents are listed in the continuation of Box C.


* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"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)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"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

"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

"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

"&" document member of the same patent family

Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 14/21317

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

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

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims 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. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

see extra 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 additional fees, this Authority did not invite payment of additional fees.
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.:
1-19

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 14/21317

Continuation of Box No. III -- Observations where unity of invention is lacking

Group I: claims 1-19: drawn to an optical system that defines an optical path comprising a body that includes a plurality of points of interest and means disposed in the optical path for enabling observation of each of the plurality of points of interest substantially simultaneously, wherein the means defines a ray length from each point of interest to a common reference point whose distance from the plurality of points of interest is less than or equal to a predetermine distance and wherein the ray lengths are substantially equal in length.

Group II: claims 20-35: drawn to an optical system that defines an optical path comprising a body including a plurality of points of interest and one or more elements that define one or more curved surface that are disposed in the optical path, wherein the curved surface collectively defined a ray length from each point of interest to a common reference point whose distance from the points of interest is less than or equal to a predetermined distance, and wherein the ray length are substantially the same.

Group III: claims 36-44: drawn to an apparatus comprising a thermocycling system having a sample subjecting to thermal cycling, an optical system configured and arranged for monitoring fluorescence in the sample comprising an illumination light source, a bandpass filter, and a camera.

The inventions listed as Groups I-III do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

Special technical features:

Group I requires means for observing plurality of points of interest wherein the means defines a ray length from each point of interest to a common reference point whose distance from the plurality of points of interest is less than or equal to a predetermine distance and wherein the ray lengths are substantially equal in length, not found in the other groups.

Group II requires a curved surface defining a ray length from each point of interest to a common reference point whose distance from the points of interest is less than or equal to a predetermined distance, and wherein the ray length are substantially the same, not found in the other groups.

Group III requires a sample subjecting to thermal cycling, an optical system configured and arranged for monitoring fluorescence in the sample comprising an illumination light source, a bandpass filter, and a camera, not found in the other groups.

Shared Features:

The only technical features shared by Groups I-III that would otherwise unify the groups are an optical system that defines an optical path comprising a body that include a plurality of points of interest and includes ray lengths that are substantially equal in length.

Further, the only additional technical features shared by Groups II and III that would otherwise unify the groups are thermocycling system for subjecting a plurality of biological sample to thermal cycling.

However, these shared technical features do not represent a contribution over prior art, because the shared technical features are disclosed by US 3,927,944 A to Iwahashi et al. (hereinafter 'Iwahashi') 23 December 1975 (23.12.1975) and US 2012/0045756 A1 to Rothmann et al. (hereinafter 'Rothmann') 23 February 2012 (23.02.2012).

Iwahashi discloses an optical system (col 1, ln 8-32) that may be used to measure the spectral change which a sample (col 2, ln 4-17) and the optical system defines an optical path comprising a body that include a plurality of points of interest and includes ray lengths that are substantially equal in length (col. 2, ln 39-41, col 3, ln 34-63).

Rothmann discloses an optical system which discloses a thermocycling system for subjecting a plurality of biological samples to thermocycling which includes an optical system (para [0006], [0023], [0029], [0119]).

It would have obvious to one of skill in the art to use the optical system of Iwahashi, with the thermocycling system of Rothmann, to provide a means to detect labeled probes in the sample.

As the shared technical features were known in the art at the time of the invention, they cannot be considered special technical features that would otherwise unify the groups.

Groups I-III therefore lack unity under PCT Rule 13 because they do not share a same or corresponding special technical feature.