



(43) International Publication Date
17 December 2015 (17.12.2015)

(51) International Patent Classification:
H01S 3/10 (2006.01)

(21) International Application Number:
PCT/US2015/035474

(22) International Filing Date:
12 June 2015 (12.06.2015)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
62/011,243 12 June 2014 (12.06.2014) US

(71) Applicant: SEAGATE TECHNOLOGY LLC [US/US];
10200 South De Anza Boulevard, Cupertino, CA 95014
(US).

(72) Inventors: TATAH, Karim; 6276 Wessel Court, Eden
Prairie, MN 55346 (US). ASSELIN, Pierre; 6829 Xerxes
Avenue South, Richfield, MN 55423 (US).

(74) Agent: PRIBNOW, Scott; Seagate Technology LLC, 7801
Computer Avenue S, Bloomington, MN 55435 (US).

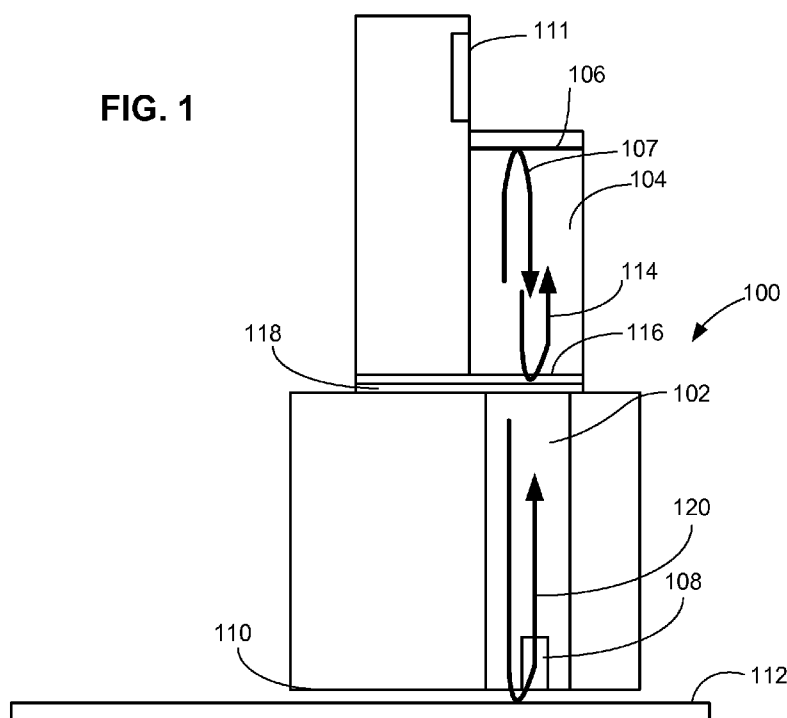
(81) Designated States (unless otherwise indicated, for every
kind of national protection available): AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY,
BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM,
DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,
HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR,
KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG,
MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM,
PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC,
SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN,
TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every
kind of regional protection available): ARIPO (BW, GH,
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ,
TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU,
TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE,
DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LI, LU,
LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK,
SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ,
GW, KM, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: BRAGG GRATING EXTERNAL CAVITY LASER

FIG. 1



(57) Abstract: A Bragg grating external cavity laser apparatus may comprise the combination of a slider and an external cavity laser. The slider includes a waveguide that delivers light to a recording media. The external cavity laser includes an active region with a reflective back facet and a front facet that is externally coupled to the waveguide of the slider. The external cavity laser additionally includes a Bragg grating within the waveguide of the slider where the reflective back facet and the Bragg grating operate to define a single resonator within the external cavity.

WO 2015/191952 A1



Published:

— *with international search report (Art. 21(3))*

BRAGG GRATING EXTERNAL CAVITY LASER**SUMMARY**

5 A Bragg grating external cavity laser apparatus may comprise the combination of a slider and an external cavity laser. The slider includes a waveguide that delivers light to a recording media. The external cavity laser includes an active region with a reflective back facet and a front facet that is externally coupled to the waveguide of the slider. The external cavity laser additionally includes a Bragg grating within the waveguide of the slider where the reflective back facet and the Bragg grating operate to define a single
10 resonator within the external cavity.

A Bragg grating external cavity laser apparatus may comprise the combination of a slider and an external cavity laser. The slider includes a waveguide that delivers light to a recording media. The external cavity laser includes an active region with a reflective back facet and a front facet that is externally coupled to the waveguide of the slider. The
15 external cavity laser additionally includes a Bragg grating within the waveguide of the slider where the reflective back facet and the Bragg grating operate to define a single resonator within the external cavity. The Bragg grating is tuned to enable a selected light wavelength to pass through the Bragg grating and to reflect all other light wavelengths into the internal cavity.

20 A Bragg grating external cavity laser method may comprise generating a beam of light, anti-reflectively coupling the light into a slider waveguide, transmitting selected wavelengths of the coupled light through the waveguide and reflecting other wavelengths of the coupled light to establish a single longitudinal mode in the waveguide.

The above summary is not intended to describe each embodiment or every
25 implementation. A more complete understanding will become apparent and appreciated by referring to the following detailed description and claims in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic representation of a portion of a slider coupled to a laser diode.

FIG. 2 is a schematic representation of a portion of a slider coupled to a laser diode
5 in accordance with various embodiments described herein.

FIG. 3 is a cross-section taken along line 3-3 of FIG. 2.

FIG. 4 is a graph depicting Bragg mirror reflectivity with varying peak reflectivity and spectral width.

FIGS. 5-7 illustrate example embodiments of the waveguide of a slider
10 incorporating a Bragg grating in accordance with various embodiments described herein.

FIG. 8 is a flowchart of a method according to an example embodiment.

The figures are not necessarily to scale. Like numbers used in the figures refer to like components. However, it will be understood that the use of a number to refer to a component in a given figure is not intended to limit the component in another figure
15 labeled with the same number.

DETAILED DESCRIPTION

Heat assisted magnetic recording (HAMR) generally refers to the concept of locally heating a recording media to reduce the coercivity of the media so that an applied magnetic writing field can more easily direct the magnetization of the media during the
20 temporary magnetic softening of the media caused by the heat source. The heated area in the storage layer usually determines the data bit dimension. A tightly confined, high power light spot is used to heat a portion of the recording media to substantially reduce the coercivity of the heated portion. Then the heated portion is subjected to a magnetic field that sets the direction of magnetization of the heated portion. In this manner the coercivity
25 of the media at ambient temperature can be much higher than the coercivity during recording, thereby enabling stability of the recorded bits at much higher storage densities and with much smaller bit cells.

The recording media may be heated using a light beam generated by a laser diode and coupled into the recording head. Because the waveguide structure inside the laser diode is quite different from the guiding structure inside the recording head, challenges exist in establishing a desirable design for coupling the output of the laser diode to the recording head. One particular problem to note is the power instabilities, or jumps, experienced by the laser diode whenever there is external optical feedback to the laser. The power jumps can be as high as 25%. The power jumps may cause jitter instability in heat assisted magnetic recording which has a direct impact on the signal-to-noise ratio, areal density, and bit error rate in the recording process.

FIG. 1 is a schematic representation of a portion of a slider 100, also known as a recording head, which illustrates the locations of problematic optical feedback. The slider 100 includes a waveguide 102 that is coupled to a laser diode portion 104, having a reflecting back facet 106 (reflecting light indicated by arrow 107), to provide light energy to near field transducer (NFT) 108 at the air bearing surface (ABS) 110. A detector 111 resides proximate laser diode portion 104 while a magnetic storage medium 112 is positioned proximate the ABS 110. Arrow 114 indicates optical feedback that occurs between the front laser facet 116 and the optical coupler 118 interface. Arrow 120 indicates additional optical feedback that occurs at the ABS 110 – magnetic storage medium 112 interface. This optical feedback introduces mode selectivity between the internal laser resonator and the external resonator, which includes the front laser facet 116 and the external reflector (magnetic storage medium 112). Mode competition among these resonators induced by laser gain shift with injected current and self-heat leads to power jump instabilities

The present disclosure provides a laser cavity design that substantially avoids multiple cavity mode competitions and mode hopping power instabilities by utilizing a single distributed Bragg grating (DBR) external cavity. More specifically, the present disclosure is directed to an external cavity laser that combines the laser gain medium to an external cavity formed using a Bragg grating, built in the integrated optic space of the slider, and the back facet of the laser diode. An example embodiment of an apparatus of the present disclosure is illustrated in FIG. 2. Here a slider 200 includes a waveguide 202 that is coupled to a laser diode portion 204, having a reflecting back facet 206, to provide

light energy to a near field transducer (NFT) 208 at an air bearing surface (ABS) 210. A detector 211 resides proximate laser diode 204 while a magnetic storage medium 212 is positioned proximate the ABS 210. Further included within the waveguide 202 of the slider is a Bragg grating 214. The Bragg grating 214 forms a resonator together with the reflecting back facet, and together they form an external cavity laser 215. A cross-section of FIG. 2 is provided in FIG. 3 and illustrates further detail of the embodiment.

As shown in FIG. 3, the laser diode portion 204 includes the reflecting back facet 206, which in one embodiment provides approximately 95% reflection of the laser diode energy. The laser diode portion 204 further includes a laser front facet 216, which is coated in an anti-reflective coating, and a laser active region 217, which has a length in the approximate range of 350 to 500 μm . The slider 200 includes a slider coupler 218 that is additionally coated with an anti-reflective coating such that the interface between the laser front facet 216 and the slider coupler 218 has a reflectivity of less than 0.2 to 1.0 %. A Bragg grating 224, having a length in the approximate range of 200 to 500 μm , is provided within the waveguide 202. The Bragg grating 224 forms the output coupler of the external cavity laser 215 that is established by the single resonator formation of the laser back facet reflector 216 and the Bragg grating 224. Light reflection points are indicated with returning arrows 226 and 228 while straight arrows 230 and 232 indicate the transmission of light to and from the Bragg grating 224.

The Bragg grating 224, also known as a distributed Bragg reflector (DBR), allows light of a certain wavelength from the laser diode 204 to pass through the waveguide 202 to the magnetic storage medium 212 while all other light wavelengths are reflected back from the Bragg grating 224 into the laser cavity. Approximately 50% of the light energy reaching the magnetic storage medium 212 may be reflected by the magnetic storage medium 212 back into the waveguide 202; however, the medium-reflected light is essentially stopped by the Bragg grating 224 preventing it from reaching the laser cavity. Some losses do occur within the waveguide 202 due to material imperfections and/or imperfect alignment of optical components and, as such, some medium-reflected light does reach the laser diode 204; this reflection is generally estimated as in the 7 to 10% range.

Note that the gain for a given current injection to the laser diode 204 needs to overcome any loss in the external cavity for lasing to occur. Once the current bias level is reached for the gain to compensate for any loss the laser diode 204 will provide sufficient power for the NFT to drive the magnetic storage medium 212 to the Curie temperature needed in heat assisted magnetic recording. The laser threshold of the presently disclosed external cavity, Bragg grating laser is substantially equivalent, or at most 10% higher, than the laser diode without an external cavity as described in relation to FIG. 1. This is because the overall light intensity returning to the external cavity laser is on the order of 5 to 20% equivalent to the laser of FIG. 1 with 5 to 15% return for the front facet of the laser.

The Bragg grating may be designed specific to the slider in which it resides. For example, the Bragg grating may reside in the waveguide or the cladding of the waveguide, the Bragg grating may be tuned to allow a desired wavelength of light to pass, and/or the grating strength may be adjusted to achieve desired peak reflectivity. A non-limiting example of distributed Bragg grating (DBR) design is provided below for reference.

Example:

A reasonable performing external cavity DBR (EC-DBR) laser includes a rear facet with 95% reflection and effective front facet reflectivity of 5 to 15%. The front facet effective reflectivity is composed of the coupling efficiency between laser and waveguide and Bragg grating reflectivity. In order for the EC-DBR laser to have reasonable laser threshold currents comparable to a single internal cavity laser diode the $R_{BG-effective}$ is computed to be $\sim 22\%$. This is obtained from the current threshold scaling with gain fill factor and effective front mirror reflectivity

$$I_{th}^{DBR-EC} / I_{th}^{LD} \sim (L_{EC} / L_{LD}) * [\ln(R_{BG-effective}) / \ln(R_{FF})].$$

This effective reflectivity includes round trip coupling loss between laser and waveguide which is $0.7^2 \sim 0.5$. The Bragg Reflector required is then around 45%.

A grating reflectivity around 42% is achieved using a waveguide core grating with index high of 2.1 for TaO and index low of 1.6 for Alumina. This is computed from DBR theory (see “Diode Laser and Photonic Integrated Circuits” by Coldren et al.). The DBR reflectivity is calculated

$$R \sim ((1 - n_{\text{low}}/n_{\text{high}}) 2^N) / (1 + (n_{\text{low}}/n_{\text{high}}) 2^N)^2$$

with n_{low} is the low index section, n_{high} is high index section within the grating period and N is the number of periods within the DBR. The grating period is an effective half wave ($\lambda/2 \cdot n_{\text{eff}}$) or with $0.23 \mu\text{m}$ length and 50% fill factor. The number of periods chosen is 5 to 6, implying 1 to $2 \mu\text{m}$ grating lengths. The grating fits easily within the slider waveguide optics. Relaxing the index of refraction contrast of the gratings will increase the number of periods and increase the length. An optimum grating design can then be calculated using BeamProp/FullWave and LaserMOD waveguide/grating and laser design software. Calculation using a more accurate grating theory (Coldren) yields the plots of FIG. 4. The 50% reflectivity curve in FIG. 4 shows a spectral width of $\sim 5 \text{ nm}$. The free spectral range of the EC-DBR longitudinal mode is

$$\Delta\lambda = \lambda^2 / 2(n_{\text{GaAs}} \cdot L_{\text{LD}} + n_{\text{Guide}} \cdot L_{\text{LD-to-DBR}}).$$

The laser junction temperature may be maintained to within 10 to 20 deg. C. from laser junction temperature to off state. This maintains a laser gain that is roughly flat within self-heating induced gain wavelength excursion.

The Bragg grating described herein may be positioned and fabricated in the slider as appropriate to the specific slider design. For example, the Bragg grating may be fabricated in the slider waveguide core before a solid immersion mirror (SIM) that focuses the light to a focal point adjacent the ABS, or the Bragg grating may be fabricated within the channel waveguide prior to the NFT. Example illustrations of Bragg grating placements are provided, but not limited to, those depicted in FIGS. 5-7.

FIG. 5 illustrates an optical path 500 that includes a channel waveguide 501 receives light from a laser diode active region (not shown) at the top. Lines 502 represent

expanded light from a beam expander 503 at a bottom end of the waveguide 502. The expanded light 502 passed through a Bragg grating 506 to SIM 508, where it is focused on an NFT 509. In this example configuration, the Bragg grating 506 may be provided with circular grooves 510. Other groove shapes may be possible, e.g., arced, parabolic, hyberbolic.

FIG. 6 illustrates an optical path 600 with a waveguide 604 that receives light 602 from a laser diode active region (not shown). The light 602 exits from a beam expander 603 where it is transmitted to a first mirror 606 then reflected and transmitted through the Bragg grating 608 to a second mirror 610 and finally to SIM 612. The SIM 612 focuses the light 602 onto NFT 613. In this example configuration, the Bragg grating 608 may also be provided with circular grooves 614, or grooves with other curved/arc'd shapes.

FIG. 7 illustrates an optical path 700 with a waveguide 704 that receives light 702 from a laser diode active region (not shown). The light 702 is transmitted to a first mirror 706 and reflected to a second mirror 708 and then transmitted through the Bragg grating 710 to SIM 712. The SIM 712 focuses the light 702 onto an NFT 713. In this example configuration, the Bragg grating 710 is provided with horizontal grooves 714 and is transparent to off-axis light. Therefore the light 702 traveling between the first mirror 706 and second mirror 708 is not affected by the Bragg grating 710.

In FIG. 8, a flowchart illustrates a method according to an example embodiment. The method involves generating 800 a beam of light in an active region. The light is coupled 802 into a waveguide of a slider via an anti-reflectively coated interface between the active region and the waveguide. Selected wavelengths of the coupled light are transmitted 803 (e.g., via a Bragg grating) through the waveguide, and other wavelengths of the coupled light are reflected (e.g., via a Bragg grating) to establish a single longitudinal mode in the waveguide.

The Bragg grating external cavity laser diode embodiments of the present disclosure operate to not only remove optical feedback instabilities, e.g., power jumps, but also operate to narrow spectral line width making mode competition mute as the Bragg

grating allows for only a single longitudinal mode. The embodiments further provide for more efficient light delivery to the disk medium.

Systems, devices or methods disclosed herein may include one or more of the features structures, methods, or combination thereof described herein. For example, a
5 device or method may be implemented to include one or more of the features and/or processes above. It is intended that such device or method need not include all of the features and/or processes described herein, but may be implemented to include selected features and/or processes that provide useful structures and/or functionality.

Unless otherwise indicated, all numbers expressing feature sizes, amounts, and
10 physical properties used in the specification and claims are to be understood as being modified in all instances by the term "about." Accordingly, unless indicated to the contrary, the numerical parameters set forth in the foregoing specification and attached claims are approximations that can vary depending upon the desired properties sought to be obtained by those skilled in the art utilizing the teachings disclosed herein. The use of
15 numerical ranges by endpoints includes all numbers within that range (e.g. 1 to 5 includes 1, 1.5, 2, 2.75, 3, 3.80, 4, and 5) and any range within that range.

Various modifications and additions can be made to the disclosed embodiments discussed above. Accordingly, the scope of the present disclosure should not be limited by the particular embodiments described above, but should be defined only by the claims
20 set forth below and equivalents thereof.

CLAIMS

1. An apparatus comprising:
a slider having a waveguide that delivers light to a recording media; and
an external cavity laser comprising:
5 an active region with a reflective back facet and a front facet externally coupled to the waveguide; and
a Bragg grating within the waveguide, wherein the reflective back facet and the Bragg grating define a single resonator.
- 10 2. The apparatus of claim 1, wherein the front facet comprises an anti-reflective coating.
3. The apparatus of claim 2, wherein the waveguide includes an optical coupler adjacent the front facet of the external cavity laser and wherein the optical coupler is coated in an anti-reflective coating.
- 15 4. The apparatus of claim 1, wherein the reflective back facet provides at least 95% reflection of light generated by the external cavity laser.
5. The apparatus of claim 1, wherein the Bragg grating transmits a desired wavelength of the light to the recording media and reflects all other light wavelengths into the external cavity.
- 20 6. The apparatus of claim 1, wherein the single resonator allows only one longitudinal mode.
7. The apparatus of claim 1, wherein the Bragg grating is located within a cladding layer of the waveguide.
8. An apparatus comprising:
25 a slider having a waveguide that delivers light to a recording media; and
an external cavity laser comprising:
an active region with a reflective back facet and a front facet externally coupled to the waveguide; and

a Bragg grating within the waveguide, wherein the reflective back facet and the Bragg grating define a single resonator, wherein the Bragg grating is tuned to enable only selected light wavelengths to pass through the Bragg grating and to reflect all other light wavelengths into the external cavity.

5 9. The apparatus of claim 8, wherein a grating strength of the Bragg grating is adjusted to achieve a desired peak reflectivity.

10. The apparatus of claim 8, wherein the front facet comprises an anti-reflective coating.

10 11. The apparatus of claim 10, wherein the waveguide includes a coupler interface adjacent the front facet of the external cavity laser and wherein the coupler interface is coated in an anti-reflective coating.

12. The apparatus of claim 8, wherein the reflective back facet provides at least 95% reflection of light generated by the external cavity laser.

15 13. The apparatus of claim 8, wherein the single resonator allows only one longitudinal mode.

14. The apparatus of claim 8, wherein the Bragg grating is located within a cladding layer of the waveguide.

20 15. A method comprising:
generating a beam of light in an active region;
coupling the light into a waveguide of a slider via an anti-reflectively coated interface between the active region and the waveguide;
transmitting selected wavelengths of the coupled light through the waveguide; and
reflecting other wavelengths of the coupled light to establish a single longitudinal
25 mode in the waveguide.

16. The method of claim 15, wherein generating a beam of light is performed with a laser diode active region having a front facet that is coated with an anti-reflective coating.

17. The method of claim 15, wherein the transmitting and reflecting is performed by a Bragg grating.

18. The method of claim 17, wherein the waveguide comprises a waveguide core and
5 waveguide cladding, and wherein the Bragg grating is located in the waveguide cladding.

19. The method of claim 17, further comprising expanding the light within the slider wherein the gratings are presented in an arced or circular configuration.

10 20. The method of claim 19, further comprising reflecting the light between two mirrors within the slider, and wherein the Bragg grating is located between the two mirrors.

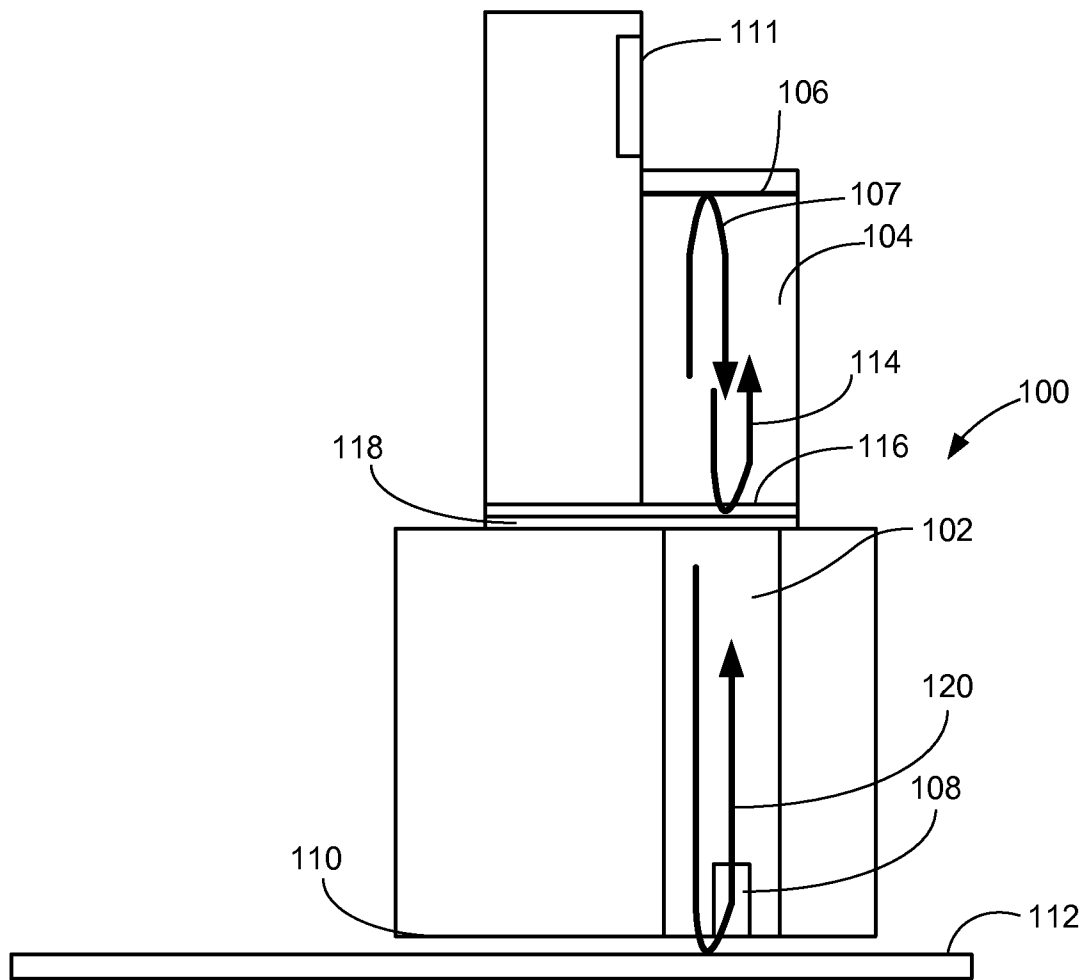
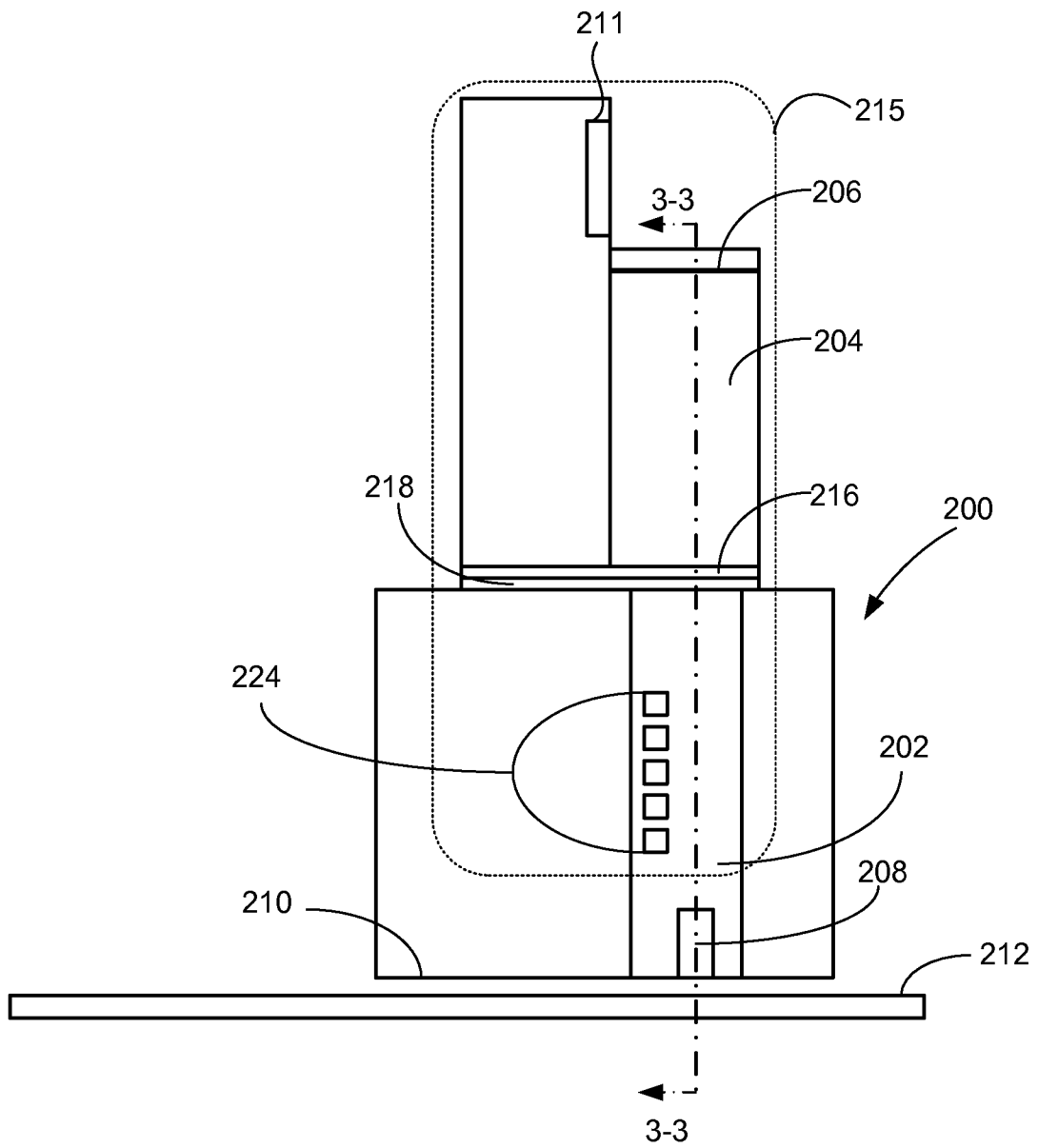


FIG. 1

**FIG. 2**

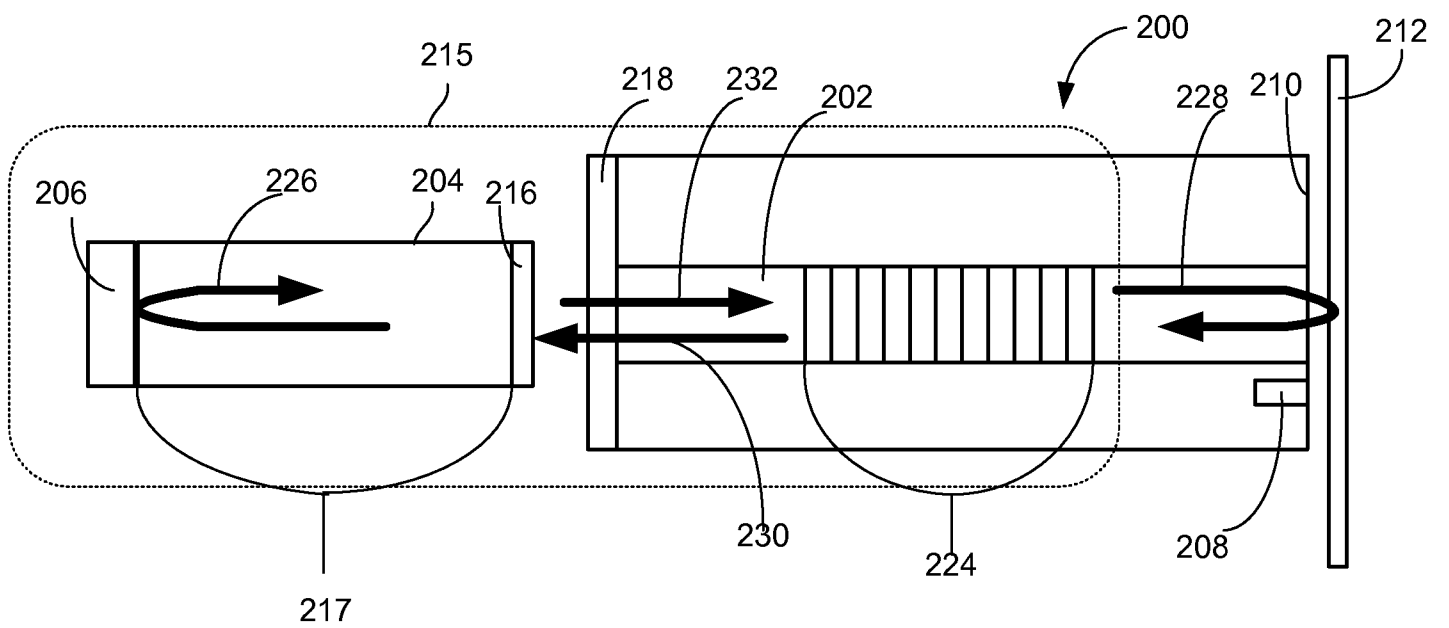
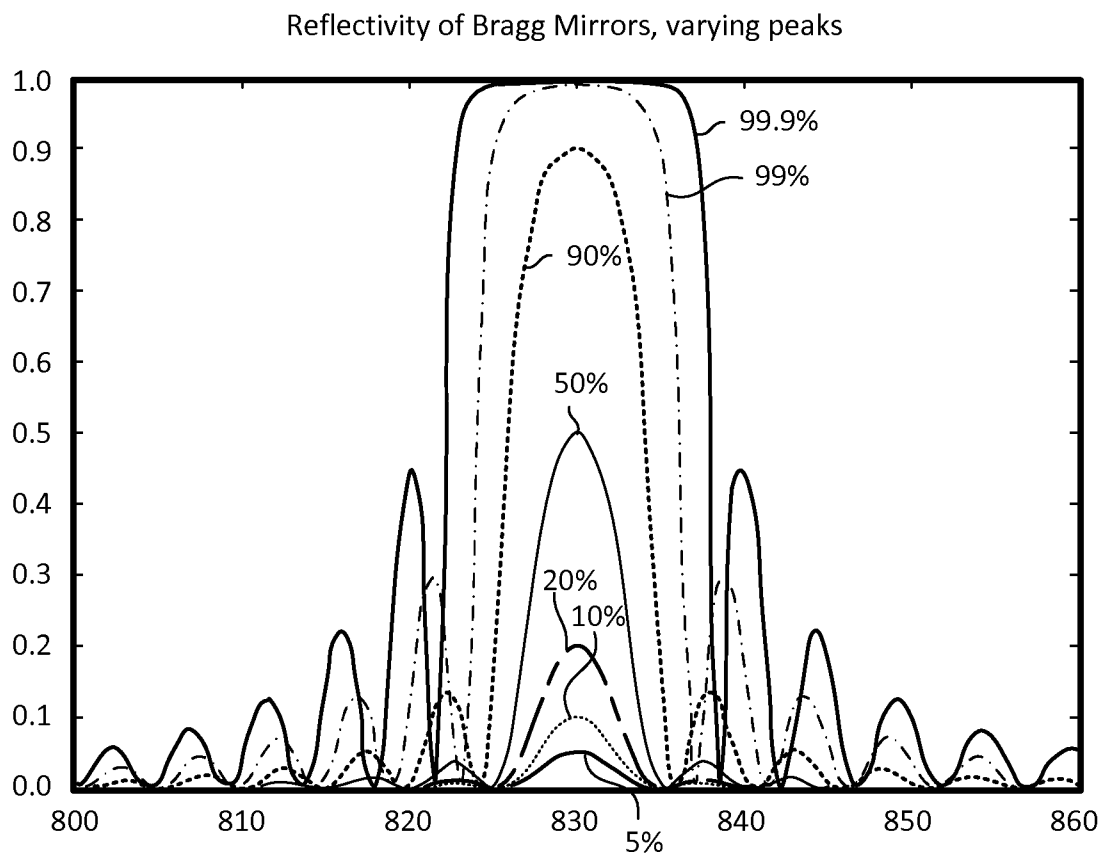


FIG. 3

**FIG. 4**

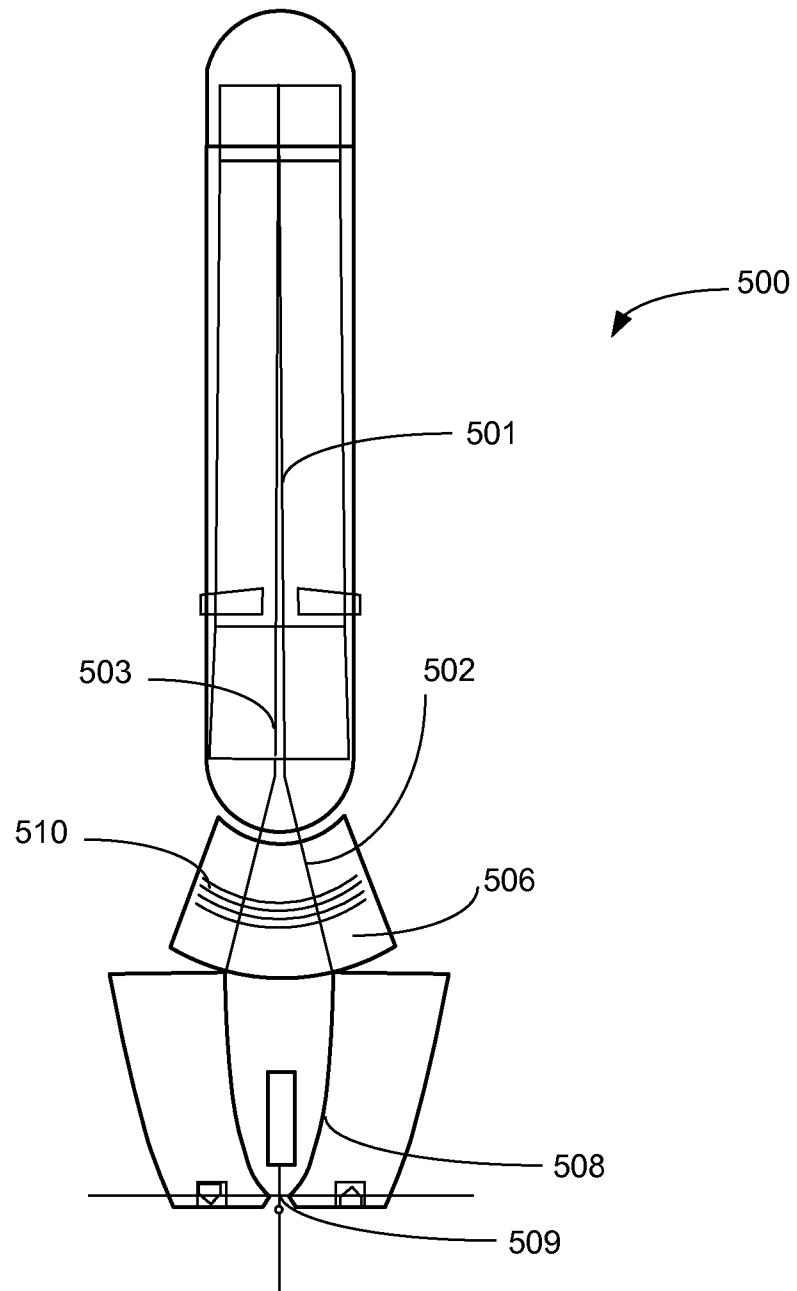


FIG. 5

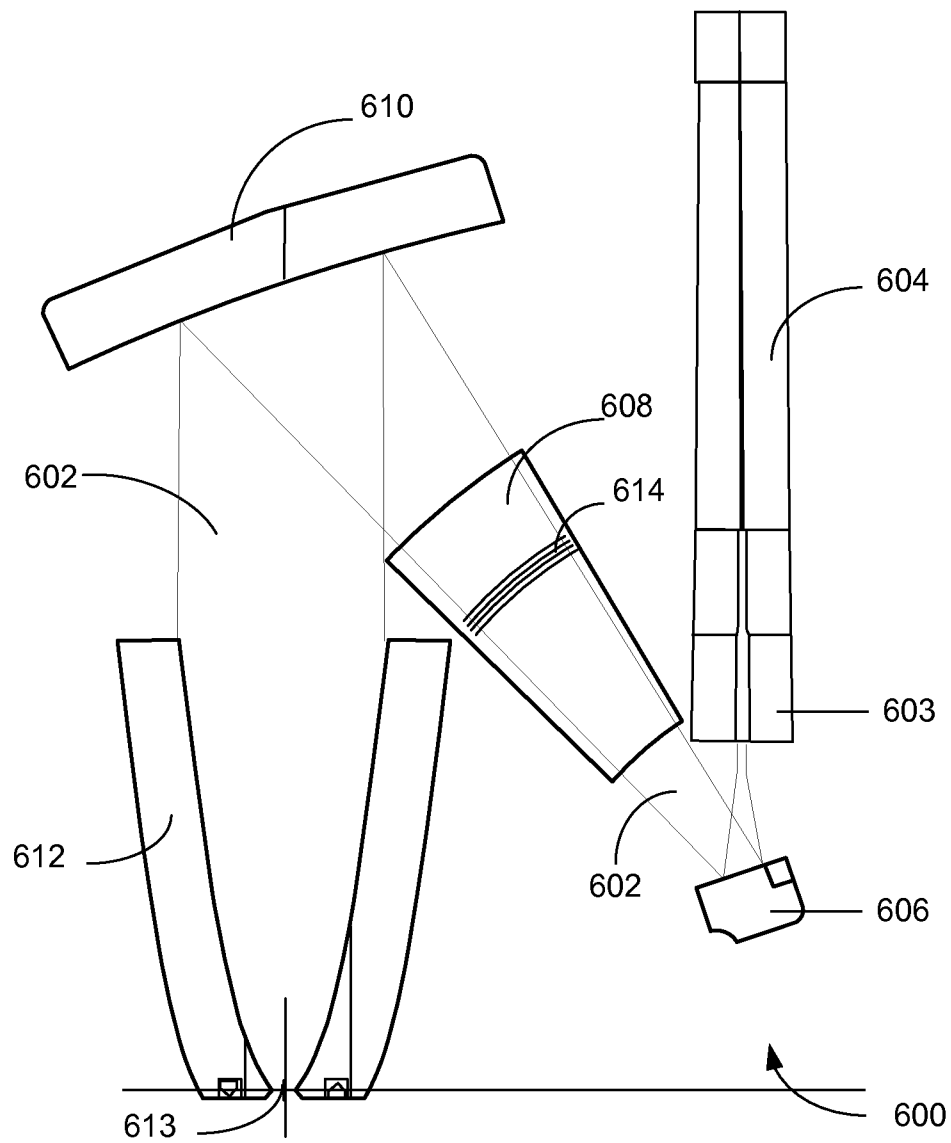


FIG. 6

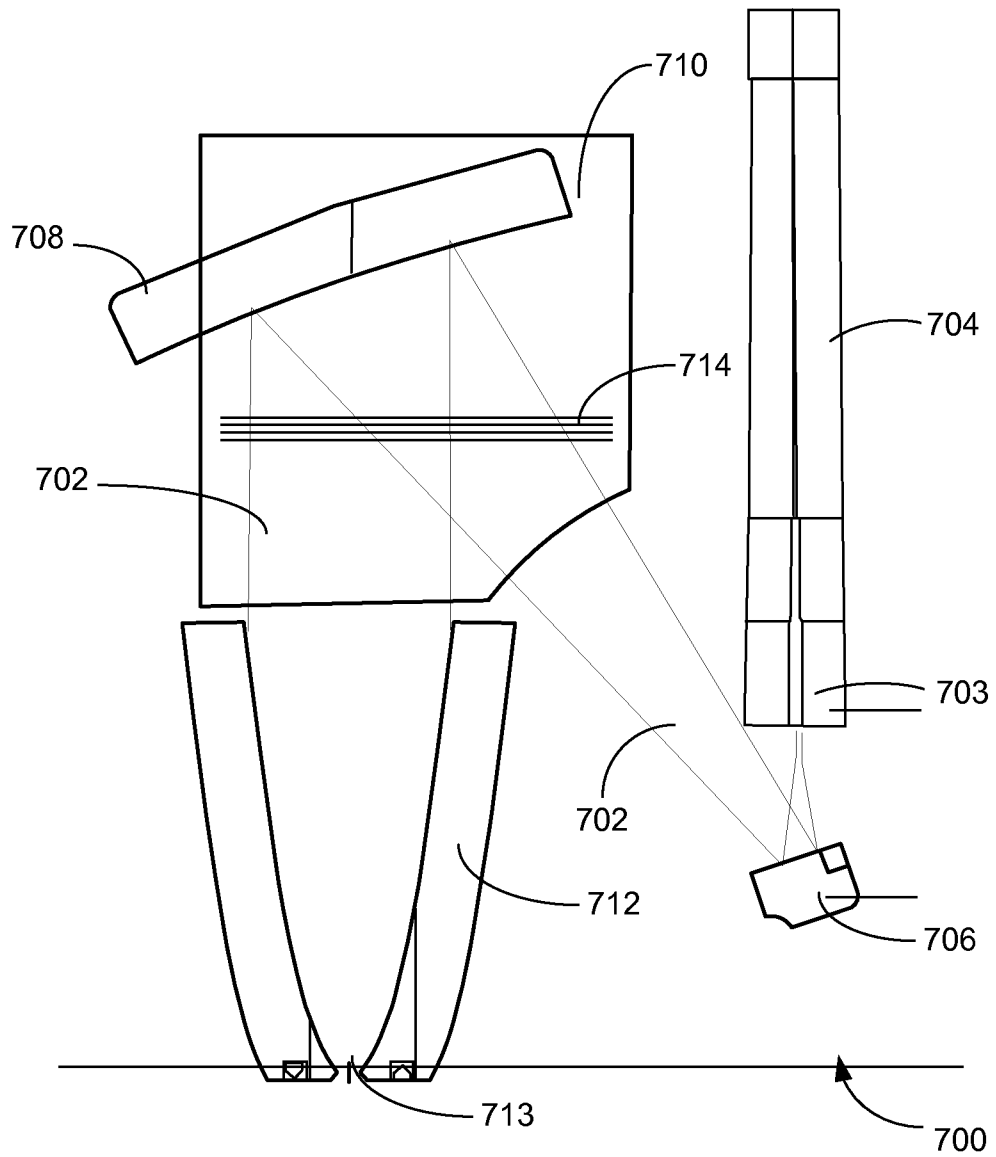
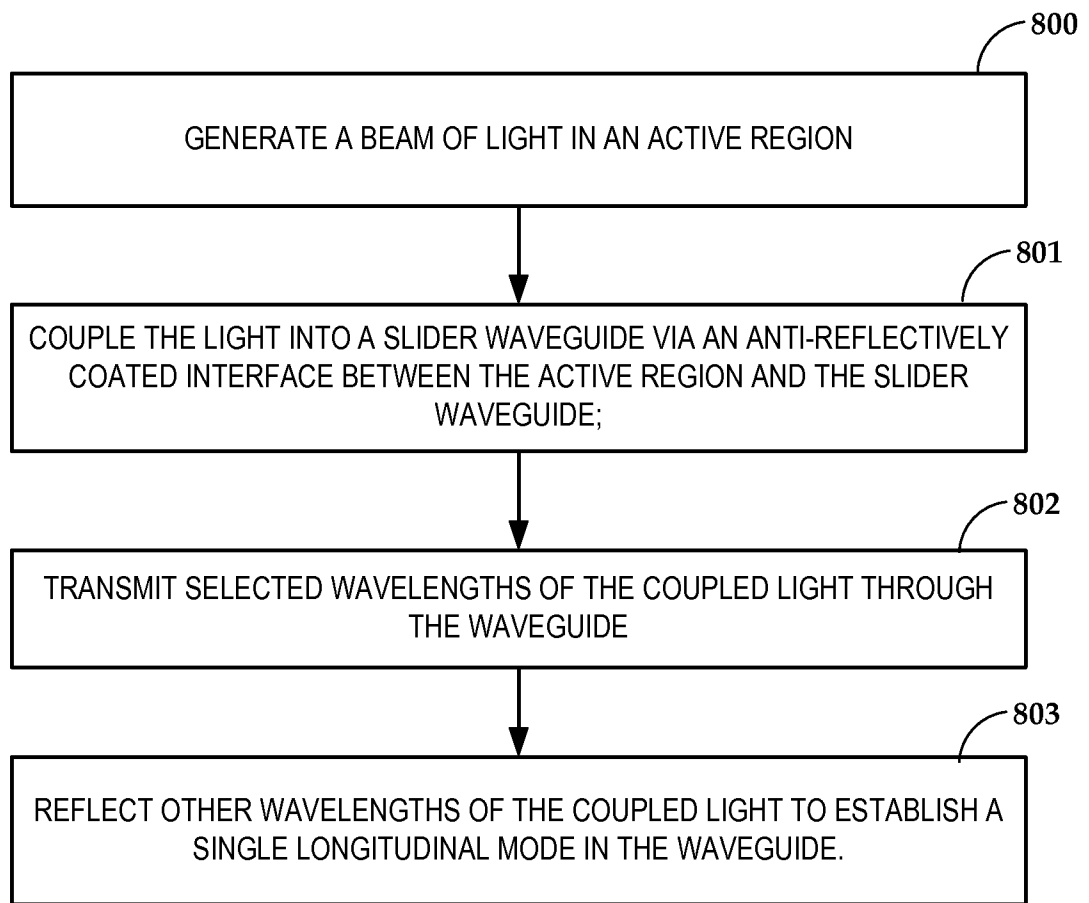


FIG. 7

**FIG. 8**

A. CLASSIFICATION OF SUBJECT MATTER**H01S 3/10(2006.01)i**

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)

H01S 3/10; H01S 3/18; H01S 3/05; G02B 27/14; G02B 6/42; H01S 3/1055; H01S 5/10; G11B 11/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords: HAMR, Heat assisted magnetic recording, external cavity laser, Bragg grating

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	KR 10-2007-0104196 A (KOREA ELECTRONICS AND TELECOMMUNICATIONS RESEARCH INSTITUTE) 25 October 2007 See paragraphs [0021]–[0085] and figure 1.	1–14
Y	US 8379494 B2 (CHUBING PENG et al.) 19 February 2013 See column 2, line 39 – column 3, line 56 and figures 2,3.	1–20
Y	JP 11-233895 A (FURUKAWA ELECTRIC CO., LTD.) 27 August 1999 See paragraphs [0004]–[0006], [0016] and figures 1,3	6,9,15–20
A	JP 09-153659 A (SUMITOMO ELECTRIC IND LTD.) 10 June 1997 See paragraphs [0017]–[0021] and figure 1.	1–20
A	US 2001-0010599 A1 (HERVE LEFEVRE) 02 August 2001 See paragraphs [0051], [0052] and figure 4.	1–20



Further documents are listed in the continuation of Box C.



See patent family annex.

* 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

27 August 2015 (27.08.2015)

Date of mailing of the international search report

27 August 2015 (27.08.2015)

Name and mailing address of the ISA/KR

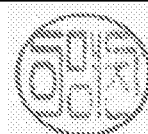
International Application Division
Korean Intellectual Property Office
189 Cheongsu-ro, Seo-gu, Daejeon Metropolitan City, 35208,
Republic of Korea

Facsimile No. +82-42-472-7140

Authorized officer

LEE, Myung Jin

Telephone No. +82-42-481-8474



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2015/035474

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
KR 10-2007-0104196 A	25/10/2007	JP 2009-529782 A KR 10-0772529 B1 US 2010-0232458 A1 WO 2007-123334 A1	20/08/2009 01/11/2007 16/09/2010 01/11/2007
US 8379494 B2	19/02/2013	CN 102629474 A EP 2485215 A1 EP 2485215 B1 JP 05479508 B2 JP 2012-163959 A US 2012-0201107 A1	08/08/2012 08/08/2012 04/06/2014 23/04/2014 30/08/2012 09/08/2012
JP 11-233895 A	27/08/1999	JP 4176860 B2	05/11/2008
JP 09-153659 A	10/06/1997	None	
US 2001-0010599 A1	02/08/2001	DK 1030418 T3 DK 1030419 T3 EP 1030418 A1 EP 1030418 B1 EP 1030419 A1 EP 1030419 B1 FR 2789812 A1 FR 2789812 B1 JP 04425409 B2 JP 04425411 B2 JP 2000-286486 A JP 2000-299519 A US 06252718 B1 US 06339609 B2 US 06519269 B1	14/02/2005 08/03/2004 23/08/2000 13/10/2004 23/08/2000 02/01/2004 18/08/2000 27/04/2001 03/03/2010 03/03/2010 13/10/2000 24/10/2000 26/06/2001 15/01/2002 11/02/2003