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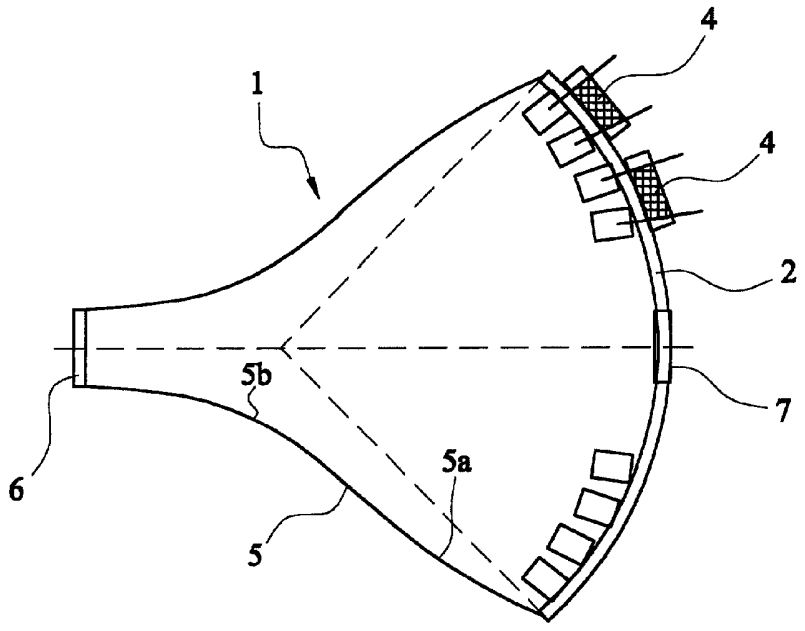
(54) **Title:** LIGHT EMITTING AND FOCUSSING DEVICE



(57) **Abstract:** The light emitting apparatus unit has an array zone of an array of light emitting devices (3) and a light output portion (6) spaced from the array zone. Light guide means guides (5) the light between the array zone and the output portion and tending to concentrate or focus the light to provide a concentrated beam exiting the light output portion of the unit. The unit may beneficially include a light input port (7) for mate up with a light output portion of a like mated unit in order to provide a cascaded light system.

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— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

LIGHT EMITTING AND FOCUSSING DEVICE

The present invention relates to a light emitting apparatus unit.

The invention is suitable for application in a wide range of applications, such as (for example and without limitation) consumer and domestic applications, industrial applications and also medical, healthcare and cosmetic use as well as use in other industries including telecommunications.

There are numerous instances where high intensity light is required from light emitters such as semiconductor light transmitters. An exemplary class of device to which the present invention is application includes all forms of Light Emitting Diodes (LED's) and semiconductor lasers.

The intensity of the light output from individual light emitter devices is frequently limited by the amount of heat such devices generate when operating. The efficiency with which the light can be focussed to a sufficiently small and sufficiently parallel beam is also of importance. An improved arrangement has now been devised.

According to a first aspect, the present invention provides light emitting apparatus unit comprising:

an array zone comprising an array of light emitting devices;

a light output portion of the apparatus spaced from the array of light emitting devices; and

light guide means for guiding the light between the array zone and the output portion and tending to concentrate or focus the light to provide a concentrated beam exiting the light output portion of the unit.

The guide means preferably comprises lens means, beneficially including a lens graded between the array zone and the output portion of the device. The lens is preferably graded to cause successive internal reflections through the lens to approximate more and more closely to a common (uniform) output direction toward the output portion of the device. The lens means may be graded by controlled variation of the refractive index between the array zone and the output zone and/or variation of the diameter of the lens surface along the axis of the device.

The guide means preferably comprises a perimeter (such as a lens perimeter) tapering to have a relatively narrow zone defined by the perimeter approximate the output portion of the device and a relatively wider zone defined by the perimeter proximate the array zone of the device.

Preferably the guide means defines a perimeter housing/exterior for the apparatus and is spaced about the central axis of the apparatus. Preferably the perimeter of the guide means has a concave surface portion (preferably approximate the array zone) and preferably a convex perimeter portion between the concave portion and the

output portion of the apparatus.

Beneficially, the guide means is arranged to provide light output from the output portion of the apparatus in which the light rays are substantially parallel.

Beneficially, the guide means comprises a body of material substantially transmissive to desired wavelengths of light (lens body) and is beneficially graded by means of a graded variation in refractive index of the material comprising the body. The guide means (lens body) optimises guiding of emitted light to conform to a uniform "straightened" path upon exiting the apparatus via the output portion of the apparatus.

The lens means may alternatively or additionally comprise a hollow tube (or a tube including a lens body material of substantially constant refractive index). The internal surface (lens surface) of the lens means being reflective and shaped to optimise straightening of the light passing along the lens means reflecting from the internal surface.

The array zone is preferably provided at a terminal end portion of the apparatus, the exterior of the terminal end of the apparatus being provided with:

heat dissipation means for effective heat dissipation from the devices comprising the array; and/or

connection means for electrical connection to the devices comprising the array.

The heat dissipation means preferably comprises heat sink means. Preferably the heat sink means comprises elements (such as blocks) of metal or other thermally conductive material such as, for example, diamond. Other cooling means may be utilised such as, for example, Peltier, forced cooling and/or micro-channel cooling.

Beneficially, the apparatus is provided with light input means in the region of the array zone for input into the apparatus of an extraneous beam of light. The extraneous source of light may be further light emitting apparatus, which may preferably be substantially identical with the light emitting apparatus according to the invention.

The light input means preferably comprises a light entry port arranged to preferably matingly receive an output portion of the further light emitting apparatus. Two or more such apparatus units may therefore be coupled together to provide a cascaded light source, the output comprising superposed light beams from coupled apparatus units.

The light entry port is preferably substantially in line (preferably co-axial) with the light output portion of the apparatus.

According to a further aspect, the invention provides a light apparatus system comprising a unit housing:

at least one light emitting device;

a light output portion of the apparatus spaced from the light emitting device;

light guide means for guiding the light between the light emitting device and the light output portion and tending to concentrate or focus the light to provide a concentrated beam exiting the light output portion of the unit; and

a light entry port permitting light to be directed into the unit from an extraneous source to be included in the light exiting the unit via the light output portion.

According to a further aspect, the invention provides a light apparatus system comprising a plurality of light emitting apparatus units according to the first or second aspect of the invention arranged in end to end coupled (cascaded) configuration.

The light output portion of a first apparatus unit is preferably co-aligned with a light input port of an adjacent/contiguous unit. The light output from the system comprises superposed output beams from the plurality of connected apparatus units.

The invention will now be further described in a specific embodiment by way of example only and with reference to the accompanying drawings in which:

Figure 1 is a schematic view of exemplary light emitting apparatus in accordance with the invention;

Figure 2 is a schematic end view of the apparatus of Figure 1;

Figure 3 is a schematic linear projection of the light emitting device array of the apparatus of Figures 1 and 2;

Figure 4 is a schematic view of an alternative embodiment closely corresponding to the embodiments of Figures 1 to 3, including a projection of the guide means (reflective lens) surface showing the graded nature of the surface;

Figure 5 is a schematic view of a slightly differently configured alternative embodiment of apparatus according to the invention;

Figure 6 is a schematic view of a cascaded apparatus array system in accordance with the invention;

Figure 7 is a perspective view of apparatus according to the invention;

Figure 8 is a schematic side view of the apparatus of Figure 7; and

Figure 9 is a schematic view of an alternative embodiment of light apparatus system according to the invention;

Figures 10a and 10b are sectional views of the system of Figure 9.

Referring to the drawings, there is shown a light emitting apparatus unit (generally designated 1) having a back wall 2 provided with an annular array zone (as shown in Figure 2) including a multiplicity of Light Emitting Diodes

(LED's) 3. The diodes 3 are mounted to back wall 2, electrical connection to the respective diodes 3 in the array being provided via the back wall 2. The external surface of back wall 2 also carries heat sink elements 4 to aid in heat dissipation from the diodes 3 in the diode array. The heat sinks 4 may, for example, comprise metal or diamond blocks (or blocks of other material of high thermal conductivity). It is believed to be a novel and inventive feature of the present invention that the diode array is mounted on the back wall of the light output device, the external surface of the back wall being provided with heat sink means for dissipation of heat from the light emitting devices (e.g. diodes 3) provided on the other side of the back wall 2.

A shaped lens surface 5 (which also defines a sidewall housing for the unit 1) tapers from a relatively wide proximity portion at the back wall 2 to a narrow light output tip portion 6 at a distal portion of the apparatus remote from the back wall 2 and diode 3 array. The output tip portion 6 is of significantly narrower cross-sectional dimensions than the dimensions of the back wall 2 and the outer peripheral dimension of the diode 3 array. The lens surface 5 includes an internal concave surface portion 5a leading to an internal convex surface portion 5b more proximate the output portion 6. A lens surface carved in this way is beneficial in promoting a concentrated output beam having substantially uni-directional rays. The general internal lens surface is generally funnel shaped in configuration.

A light inlet port 7 is provided in back wall 2, the light inlet port 7 being co-aligned with (preferably substantially co-axial with) the light output tip portion 6. The apparatus includes connection means (which may simply be push fit connection means) permitting a series of apparatus units in accordance with the invention to be connected to one another (or mounted adjacent to or contiguous with one another) in end to end configuration. This arrangement is shown most clearly in Figure 6 in which apparatus units in accordance with the invention are arranged in end to end configuration with, for example, output tip portion 6 of apparatus unit 1a directing light through the light input port of apparatus unit 1b (and so on) for units 1c and 1d.

Each apparatus unit 1 provides that light emitted from the plurality of diodes 3 in the respective annular array is guided by the internal lens surface 5 to form a concentrated beam of light exiting outlet tip portion 6. By arranging the successive apparatus units 1a, 1b, 1c etc in end to end configuration to form a "cascaded" series of apparatus units a high intensity concentrated beam can be provided from the apparatus system. The light output from the system (such as for example the system shown in Figure 6) is the sum of the light intensity output from the individual apparatus units.

A body of material 5 may be present bounded by the lens surface 5. The body of lens material may be of plastics (clear or coloured) material or any other suitable material. The refractive index of the lens body material

may be constant, or most preferably, in certain embodiments, graded in such a way as to "straighten" the light rays as they travel through the lens to provide a concentrated output beam through output tip portion 6. This has been found to result in beneficial effects in producing a concentrated uniform output beam.

The lens surface 5 typically has a reflective coating or finish on its internal surface and/or the refractive index of the lens body material may be graded such that successive internal reflections of a beam travelling from the array zone at back wall 2 via the lens body material to the output tip portion 6 are successively/incrementally straightened with progress through the unit lens body material. This is, for example, shown in schematic form in Figure 4 where the image shows the graded reflective surface from the diode 3 array to the tip 6. Light from the transmitting array flows toward the output tip portion 6 undergoing reflection from the surface 5 of the lens in such a way that each successive reflection of the light along its path causes the beam to travel in an increasingly parallel path towards the outlet tip portion 6. The graded lens surface (and/or the graded refractive index of lens body material through which the light rays travel) in combination with the concave to convex curvature of the surface has been found to be beneficial.

The light from separate apparatus units (or even the light from separate light emitting devices 3 in an individual array) may be of differing wavelengths, or the same wavelengths in differing combinations. This produces

different technical and/or aesthetic light effects and colours. The arrays may be operated continuously or in pulsed mode to create further technical or aesthetic effects. The pulse sequences for different apparatus units may be the same or pulsed differently as required by the end user application. The output tip portion of apparatus units may protrude into the internal volume of the apparatus unit to which it may be connected, and may extend a significant distance along the axis thereof.

The device is believed to have application in numerous fields in which versatility of light emitters and lighting apparatus would be of benefit. Applications include medical and healthcare, industrial, consumer and domestic (for example consumer and domestic lighting displays and arrays) and telecommunication. It is envisaged that the apparatus may have a flexible lens surface 5 or an output portion tip 6 (or neck portion leading to the tip 6) which is flexible. This would permit the apparatus units to be flexible (or non-linear) and coupled in wound coils or other non-linear configurations. The apparatus units may be coupled with various output devices depending upon the particular end use application.

Referring now to the embodiment of Figures 9 and 10, a bundle 107 of fibreoptic waveguide elements 105 defines a light transmission highway. Light from led sources 106 is passed into respective elements 105a, 105b which merge downstream into the light transmissive highway bundle 107. In this way the bundle carries increasing light intensity for output at the output of the bundle 107.

In order to ensure the overall diameter/width dimension of the bundle does not become too large, the diameter/width dimension of the individual fibreoptic elements 105 narrows with progressive distance along the bundle. This is shown clearly in Figures 10a and 10b. The narrowing of the elements 105 may be stepwise or by means of progressive narrowing/tapering.

CLAIMS:

1. A light emitting apparatus unit comprising:

an array zone comprising an array of light emitting devices;
a light output portion of the apparatus spaced from the array of light emitting devices; and
light guide means for guiding the light between the array zone and the output portion and tending to concentrate or focus the light to provide a concentrated beam exiting the light output portion of the unit.

2. A unit according to claim 1, wherein the guide means comprises lens means.

3. A unit according to claim 1 or claim 2, wherein the guide means comprises lens means, including a lens graded in refractive index between the array zone and the output portion of the device.

4. A unit according to claim 3, wherein the lens is graded to cause internal reflections through the lens to approximate more and more closely to a common (uniform) output direction toward the output portion of the device.

5. A unit according to claim 3 or claim 4, wherein the lens means is graded by controlled variation of the

refractive index between the array zone and the output zone.

6. A unit according to any of claims 3 to 5, wherein the lens means is graded by variation of the diameter of the lens surface along the axis of the device.

7. A unit according to any preceding claim, wherein the guide means comprises a perimeter (such as a lens perimeter) tapering to have a relatively narrow zone defined by the perimeter approximate the output portion of the device and a relatively wider zone defined by the perimeter proximate the array zone of the device.

8. A unit according to any preceding claim, wherein the perimeter of the guide means has a concave surface portion (preferably approximate the array zone) and preferably a convex perimeter portion between the concave portion and the output portion of the apparatus.

9. A unit according to any preceding claim, wherein the guide means is arranged to provide light output from the output portion of the apparatus in which the majority of light exiting the output portion has light rays which are substantially parallel.

10. A unit according to any preceding claim, wherein the array zone is provided proximate a terminal end portion of the apparatus, the exterior of the terminal

end of the apparatus being provided with heat dissipation means for effective heat dissipation from the devices comprising the array.

11. A unit according to any preceding claim, wherein the array zone is provided proximate a terminal end portion of the apparatus, the exterior of the terminal end of the apparatus being provided with heat dissipation means comprising a heat sink arrangement.

12. A unit according to claim 10 or claim 11, wherein heat dissipation means comprises a heat sink arrangement.

13. A unit according to claim 12, wherein the heat sink arrangement comprises elements (such as blocks) of thermally conductive material.

14. A unit according to any preceding claim including cooling means.

15. A unit according to any preceding claim including light input means for introducing light from an external source into the interior of the unit to be guided by the guide means to the light output portion of the unit.

16. A unit according to claim 15, wherein the light input means is provided in the region of the array zone for input of an extraneous beam of light.

17. A unit according to claim 15 or claim 16, wherein the

light input means comprises a light entry port.

18. A unit according to claim 17, wherein the light entry port of the unit is configured to mate-up with an output portion of a further light emitting apparatus unit.

19. A unit according to claim 18, wherein the light entry port of the unit is configured to mate-up with an output portion of an identical light emitting apparatus unit.

20. A unit according to any of claims 15 to 19, wherein the light input means is substantially in line (co-axial) with the light output portion of the apparatus.

21. A light apparatus system comprising a plurality of units, each comprising:

at least one light source;
a light output portion of the unit spaced from the light source;
light guide means for guiding the light between the light source and the output portion and tending to concentrate or focus the light to provide a concentrated beam exiting the light output portion of the unit; and
a light entry port configured to mate-up with a light output portion of an adjacent/contiguous light unit comprising the system.

22. A light apparatus system according to claim 21 comprising a plurality of units in mate-up configuration.

23. A light apparatus system comprising a plurality of discrete light units or sources, guide means for guiding light from the units or sources to a common light transmission highway.

24. A light apparatus system according to claim 23, wherein the light transmission highway leads to a common light output.

25. A light apparatus system according to claim 23 or claim 24, wherein the light transmission highway comprises a bundle or bunch of light transmission conduits extending alongside one another.

26. A light apparatus system according to claim 25, wherein the light transmission conduits comprises fibreoptic filaments, waveguides or the like.

27. A light apparatus system according to claim 25 or claim 26, wherein the number of light transmission conduits in the bundle increases along the length of the light transmission highway.

28. A light apparatus system according to any of claims 25 to 27, wherein the width of conduits in the light transmission highway bundle deceases as the number of conduits in the light transmission highway bundle

increases.

29. A light emitting apparatus unit substantially as herein described with reference to the accompanying drawings.

30. A light apparatus system substantially as herein described with reference to the accompanying drawings.

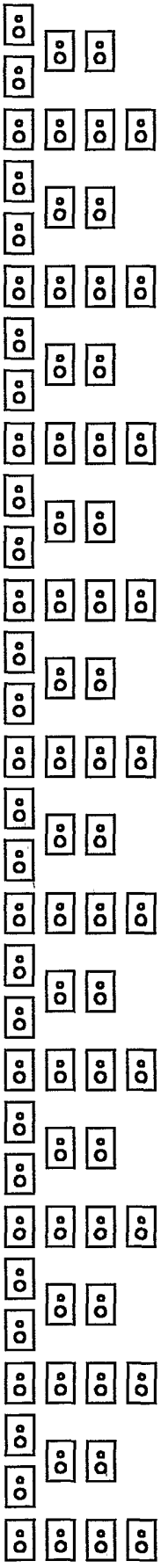


FIG. 3

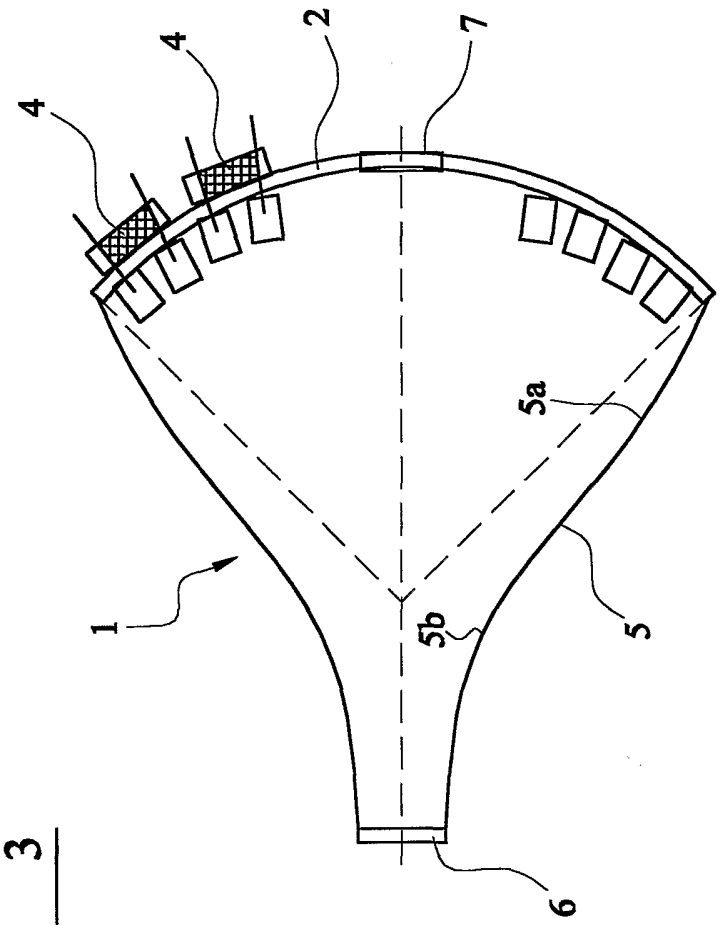


FIG. 1

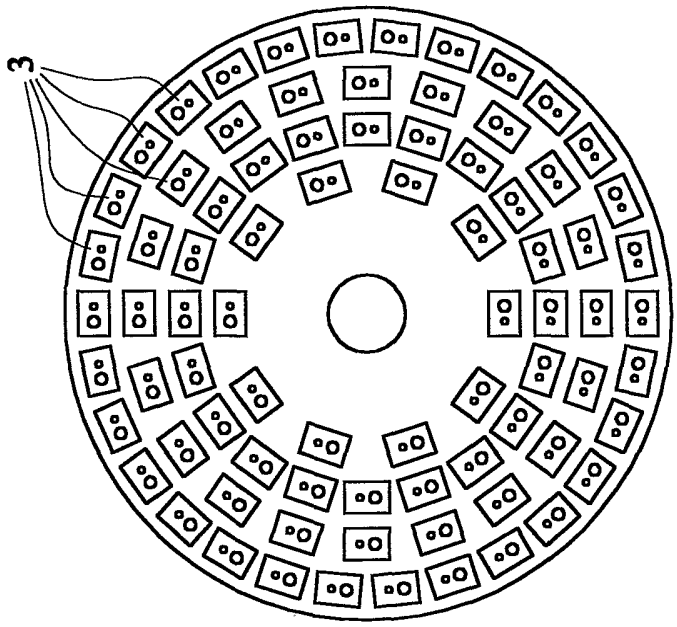


FIG. 2

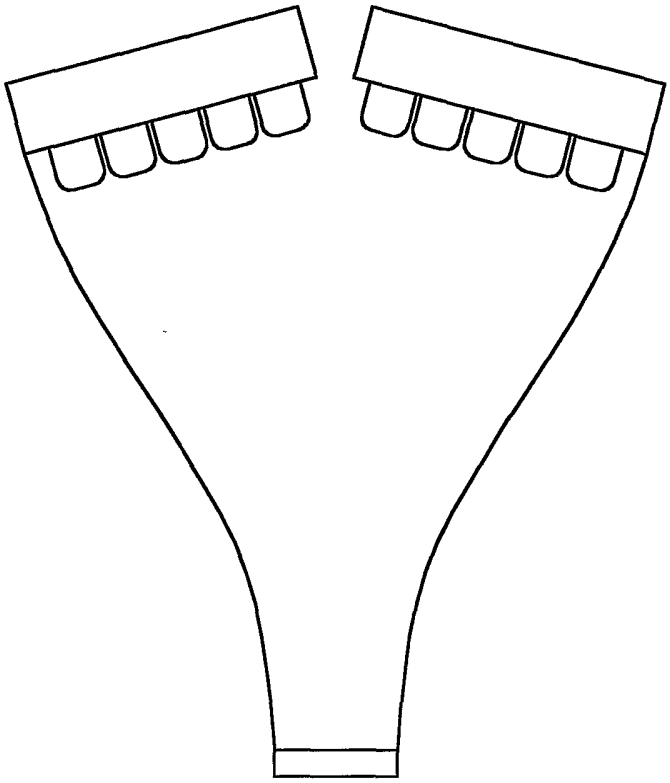


FIG. 5

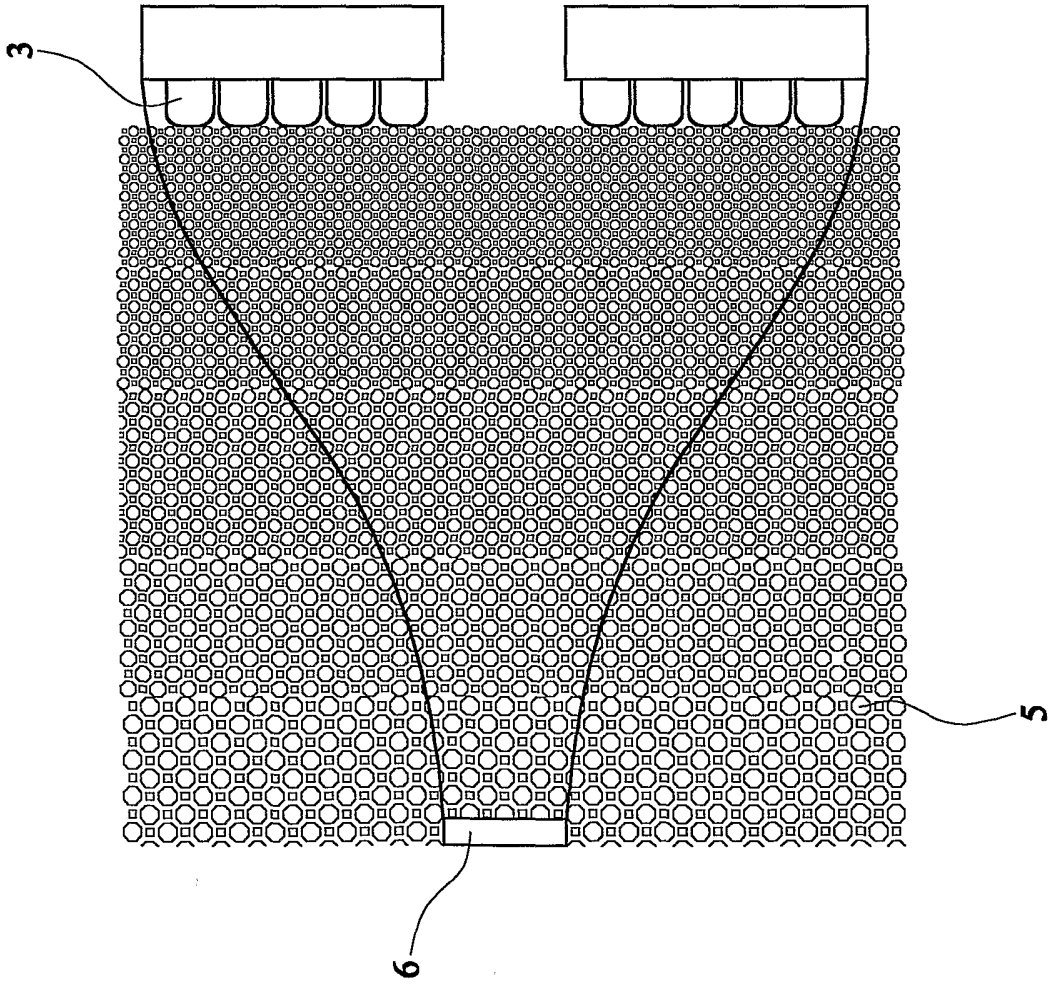


FIG. 4

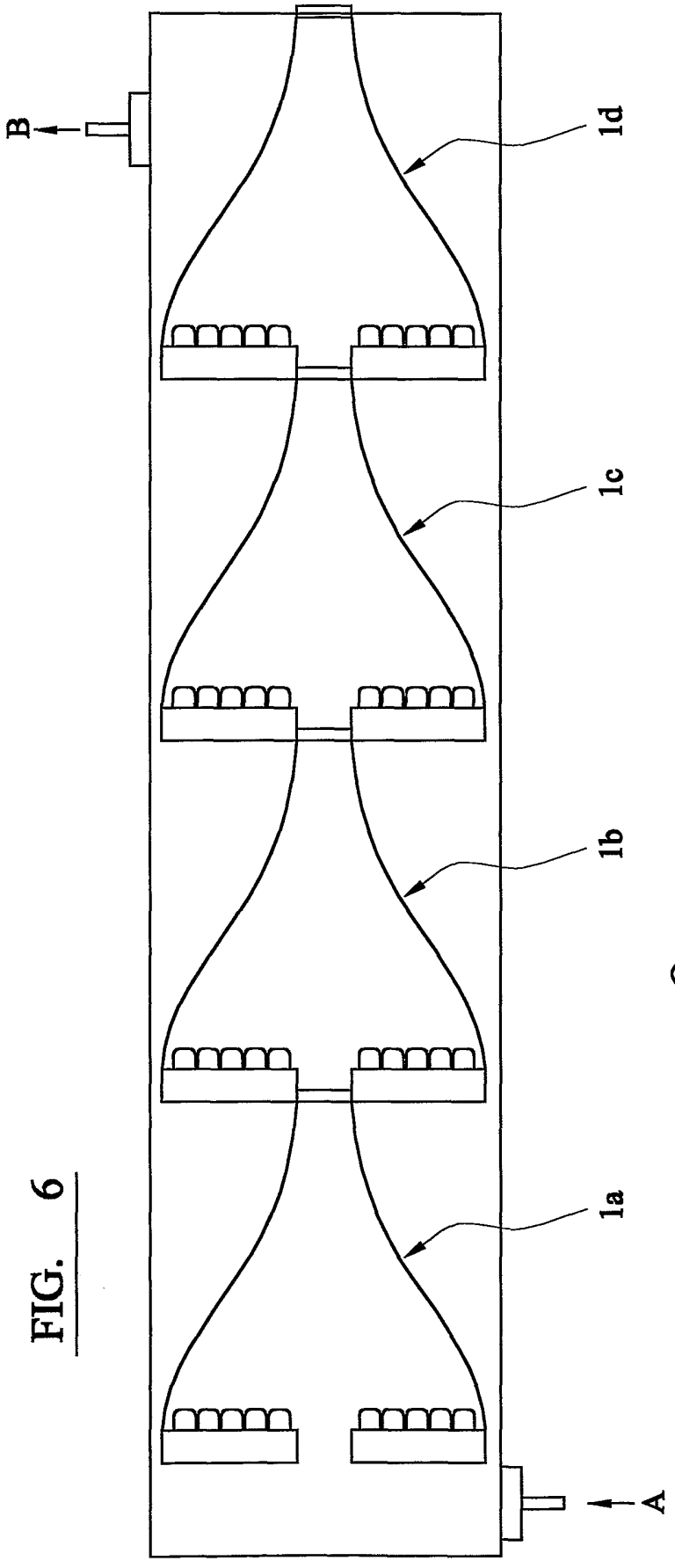


FIG. 6

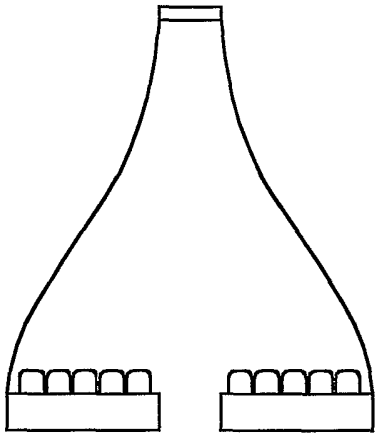


FIG. 8

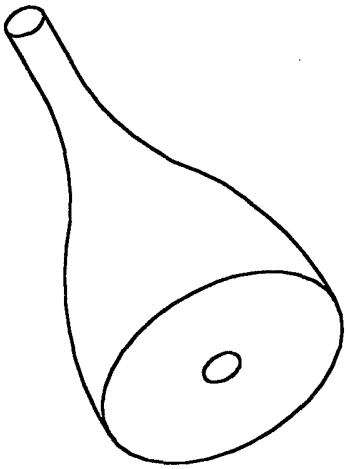


FIG. 7

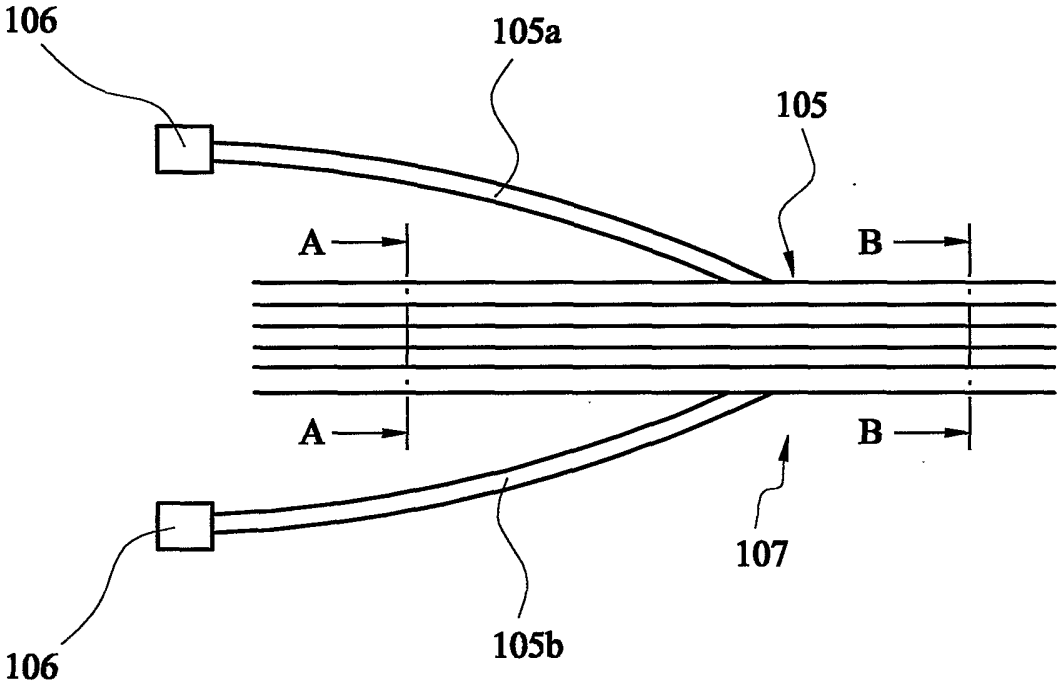
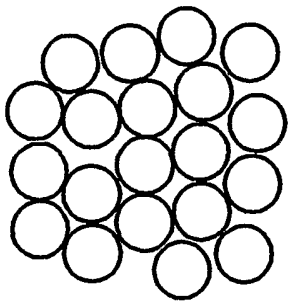
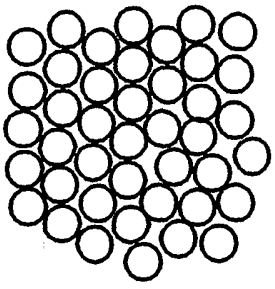


FIG. 9



SECTION A - A

FIG. 10a



SECTION B - B

FIG. 10b

INTERNATIONAL SEARCH REPORT

In tional Application No
PCT/GB 02/02439

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G02B6/43

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 7 G02B A61C

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

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

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

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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 September 2002	25/09/2002

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Wolf, S

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 02/02439

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
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