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(54) **Signal lamp**

(57) The present invention relates to a signal lamp having an LED light (LED = light emitting diode) which is in particular used in traffic signal devices or display devices like traffic lights or road signs. The signal lamp comprises an optical lens for directing the radiation emitted by a single LED or a number of LEDs efficiently at predetermined angles or in predetermined directions. The Signal lamp has a basis support (2) and at least one light means (3), preferably two or a few more electric light means (3), which together represent a quasi central light source, and which are arranged with a small distance between them on the basis support (2) within a

plane, such that the area enclosed by light means (3) comprises a maximum side value, and has a lens device (6), which is arranged in a predetermined distance in front of the light means (3) such, that said predetermined distance is greater, and especially substantially greater than the maximum side value. The light means (3) are arranged on one single circuit board (10), said circuit board housing also the electric circuits for controlling and power supplying said light means, and comprising a form part (14) fabricated of a light absorbing material, preferably synthetic material, said form part covering the circuit board (10) completely.

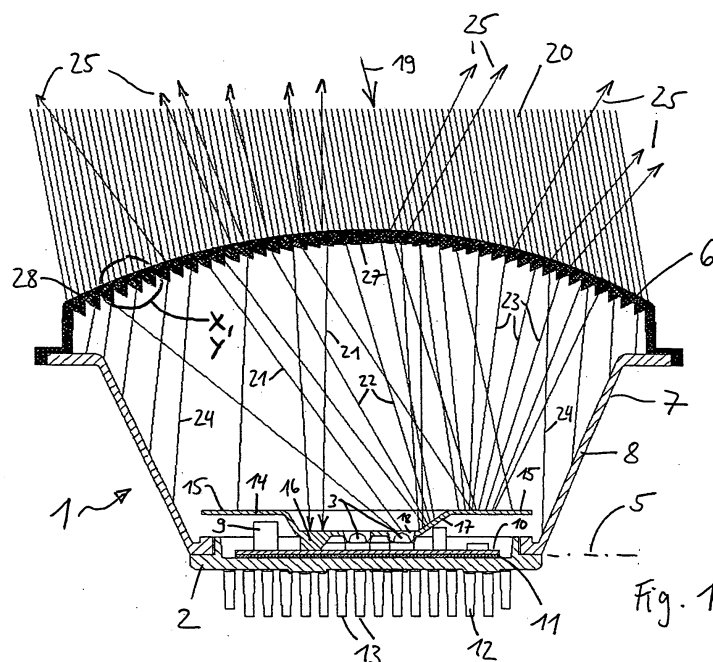


Fig. 1

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## Description

**[0001]** The present invention relates to a signal lamp having an LED light source (LED = light emitting diode) which is in particular used in traffic signal devices or display devices like traffic lights or road signs. The signal lamp comprises an optical lens for directing the radiation emitted by a single LED or a number of LEDs efficiently at predetermined angles or in predetermined directions.

**[0002]** Traffic signals and road signs with LED light sources have significant advantages compared with other light sources: a long life duration guarantees function in case of emergency and with no maintenance necessity. Power consumption is significantly low, i.e. a longer emergency supply with batteries is possible. The temperature of an LED light is low, i.e. longer function in case of fire. It is possible to realize a very flat assembly having high operational areas. A connection with several control circuits or supervision systems is possible. Strong and contrastful light colours are possible for backside enlightening or illuminating. Among the disadvantages of LED lights are the poor angle light distribution, as usual LED light sources have only a narrow radiation angle. For enabling a significant spatial distribution of the light a broad divergence of the outputted light is necessary. Further, as LEDs are heat sensitive, additional means are necessary for transferring the heat produced during the operation of the LED sources and the operation of the corresponding circuit components, or alternatively, to ensure a low operational temperature, in order to guarantee a secure operation within a broad temperature region.

**[0003]** Mainly two principal systems of signal lamps having LEDs are known in the prior art. In a first conventional system, a very high number of smaller LEDs are regularly arranged over a total light area of a basis plate. Every single LED has a lens working as a secondary optical means. In addition, such a system usually has a primary optical device, i. e. a distributing lens or other means. Whereas the primary optical device provides for the external light area, the secondary optical device has to transfer an essential part of the light radiated from the light source into useful light. Furthermore, there are means provided for suspending external light sources, in particular the so-called phantom light stemming from the sunlight; for such purposes it is known to use optical lamella or other aperture devices which are inserted between the primary and the secondary optical devices.

**[0004]** In a second known system only some few, more powerful LEDs are used which are arranged in a smaller unit on a basis plate. Such an LED unit could be provided with a secondary optical device, i. e. a fresnel lens. In most cases, there is provided in addition also a primary optical device.

**[0005]** The object of the present invention is to present an improved signal lamp having a LED light source, which can be efficiently used in external regions

within traffic lights and road signs, and which is capable to efficiently radiate the light of the LEDs within user specific predetermined angle directions, and which can be fabricated easily and with low cost.

**[0006]** This object is solved by a signal lamp according to claims 1, 9 or 15.

**[0007]** In accordance with a first aspect of the invention, the signal lamp has a basis support and at least one light means, preferably two or a few more electric light means, which together represent a quasi central source of light, and which are arranged with small distance between each of them on said basis support within a plane, such that the area enclosed by said light means has a maximum side value, and has a lens device, which is arranged in a predetermined distance in front of the light means such, that said predetermined distance is greater, and especially substantially greater than the maximum side value. The invention is characterized in that, in case of only one light means, the position, and in case of few light means, the position and the distances of the light means are adjustable according to user specific variables on the basis support.

**[0008]** Following the principles of the invention, the signal lamp has a circuit board supporting the light means, said circuit board comprising on its contact surface area several prefabricated pads for connecting said light means. The several prefabricated pads can be arranged in such way, that any number and arrangement of the light means, dependent on the user specified total light power, light performance and light characteristic is fulfilled by the signal lamp.

**[0009]** Furthermore, said circuit board can have several prefabricated boreholes for securing the circuit board on the basis support through fastening means like screw connections or pins or other means, wherein said basis support can have several holes for engaging said fastening means.

**[0010]** Depending on user specifications or for fulfilling technical standards, the predetermined or user wished angular intensity distribution of the signal lamp can be provided by a variable positioning and placing of the light means.

**[0011]** In a further, second aspect of the present invention, the signal lamp has a basis support and a light source arranged on the basis support, said light source being a central or quasi central light source, and at least forming a spot like light source, and has a lens device which is arranged at a predetermined distance in front of the light source, wherein the lens device comprises only one single combination lens consisting of a plurality of single lenses, each having differing optical angular intensity distribution.

**[0012]** Following the principles of this aspect of the invention, the combination lens has a first surface area which faces the light source and comprises an internal structure, and has a second surface area which is curved and turned away with respect to the light source. In a preferred embodiment, the internal structure of said

first surface area of the combination lens is formed by polygonal or round area parts, and is formed especially by 4- or 6-cornered area parts or by circular or oval area parts. The light radiating from the light source is distributed in predetermined directions, which are adjustable according to user specific orders, by setting the angle of each polygonal or round area part with respect to the optical axis of the signal lamp.

**[0013]** The combination lens can in addition have anti reflex areas, which are formed differently on the inside or outside of the surface with respect to the shape, the size and the position of said anti reflex areas. The anti reflex areas could be formed by roughing, matting, coloring or printing of the lens surface.

**[0014]** In a further, third aspect of the invention, the signal lamp has a basis support and at least one light means, preferably two or a few more electric light means, which together represent a quasi central light source, and which are arranged with a small distance between them on the basis support within a plane, such that the area enclosed by light means comprises a maximum side value, and with a lens device, which is arranged in a predetermined distance in front of the light means such, that said predetermined distance is greater, and especially substantially greater than the maximum side value. The single one or few light means are arranged on one single circuit board, wherein said circuit board houses also the electric circuits for controlling and power supplying said light means. The signal lamp comprises a form part fabricated of a light absorbing material, preferably synthetic material, said form part covering the circuit board completely.

**[0015]** In a preferred development of the invention, said form part comprises a wing part extended to the outside, a middle part and a sloped wall part coupling the wing part and the middle part, said parts of the form part screening all reflective parts of the basis support or of the circuit board against non wished light reflections. The form part can have drill holes or openings, in which said light means are inserted.

**[0016]** In all aspects and embodiments of the present invention, the light means are luminescent diodes, especially high power luminescent diodes. The luminescent diodes can be single semiconductor elements, or, alternatively, can be integrated parts of a semiconductor on-board unit.

**[0017]** Further details and features of the signal lamp according to the invention are disclosed in the further subclaims.

**[0018]** In the description that follows, the invention is described in detail with references to an exemplary embodiment illustrated in the drawing, in which

Figure 1 is a side view showing the signal lamp according to an embodiment of the present invention;

Figure 2 is a front view of the signal lamp;

Figure 3A is an enlarged detail X of the lens device according to Figure 1;

Figure 3B is an enlarged detail Y of the lens part according to Figure 1;

Figure 4 is a plan view of the form part;

Figure 5 is a plan view of the basis support;

Figure 6 and 7 are front views of the lens device;

Figure 8 is a sectional side view of the lens device.

**[0019]** In accordance with the exemplary embodiment of the invention shown in the Figures 1 to 8, identical reference numerals represent identical or similar features in different views or Figures.

**[0020]** The Figures show a signal lamp 1 having a basis support 2 and with at least one light means 3, preferably two or a few more electric light means 3, which together represent a quasi central source of light, and which are arranged with small distance a between each of them on said basis support 2 within a plane 5, such that the area enclosed by said light means 3 has a maximum side value s, and with a lens device 6, which is arranged in a predetermined distance b in front of the light means 3 such, that said predetermined distance b is greater, and especially substantial greater than the maximum side value s.

**[0021]** The signal lamp 1 of the embodiment is closed at all sides and comprises a housing 7 enclosing the lens device 6, the basis support 2, as well as a side wall part 8. The housing 7 could be opened from two sides by screw connections (not shown in the Figures), it is not necessary to fix the wall parts of the housing, i.e. by an adhesive. The side wall part 8 consists of a light absorbing material, i. e. a black colored material.

**[0022]** The one or few light means 3 and also the electric circuits 9 for controlling and power supplying said light means are arranged on one single circuit board 10, said circuit board 10 being coupled with a cooling element 12 through a layer 11 made from a suitable heat conducting material for transferring the heat generated during the operation of the signal lamp. In the disclosed embodiment, the cooling element 12 is formed by cooling body which comprises a number of cooling ribs 13.

**[0023]** In a further embodiment of the embodiment, which is not shown in detail, the cooling element 12 may be formed by a passive cooling body or by a heat storing element. In addition, also further, in particular active cooling elements are possible, i. e. peltier elements.

**[0024]** A form part 14 fabricated of a light absorbing material, preferably synthetic material, covers the circuit board 10 completely. Said form part 14 comprises a wing part 15 extended to the outside, a middle part 16 and a sloped wall part 17 coupling the wing part 15 and

the middle part 16, said parts 15, 16, 17 of the form part 14 screening all reflective parts of the basis support 2 or of the circuit board 10 against non wished light reflections. The middle part 16 comprises drill holes or openings 18, in which said light means 3 are inserted. With the inventive arrangement of the housing 7 having the side wall part 8, with lens device 6, and the form part 14 covering totally the circuit board 10, an almost complete reduction of phantom light is achieved, as such non-wished phantom light does not reach in or at the light means (LEDs and single reflectors corresponding with the light means), and would such reach the viewers eye, but is directed to the absorbing areas of the form part 14 and the other parts of the housing parts. This can be seen in particular from Figure 1 showing the light beam trajectories with reference numerals 20 to 25. Light beam trajectory 20 is external light (sun light) which is inputted through arrow 19 and deflected by the lens device 6 and is directed either onto the middle part 16 (light rays 21), or the wall part 17 (rays 22), or the wing part 15 (rays 23), or the side wall part 8 of the housing (rays 24) and absorbed completely. Only a small part of approx. 5 % of the external light inputted in the lens device 6 is not absorbed and is reflected to extern as light 25.

**[0025]** According to Figure 2, the inventive lens device 6 is a single combination lens fabricated as one piece and consisting a plurality of single lenses 26, each having differing optical angular intensity distribution. The combination lens 6 includes and combines the optical features of a collecting lens as well as of a fresnel lens and of a multiple filter or screening device and a antireflection device in one single optical device. The combination lens 6 has a first surface area 27, which is facing the light source and comprises an internal structure, and a second surface area 28, which is curved, but has no structured surface, and is turned away with respect to the light source. The internal structure of said first surface area 27 of the combination lens 6 is formed by polygonal or round area parts arranged side by side, and is formed especially by 4- or (as shown in the Figures) 6-cornered area parts or (not shown) by circular or oval area parts.

**[0026]** As can be seen best from Figures 3A and 3B, every single lens 26 has a curved or bent surface part 30 on the surface 26 facing the light source, said surface part 30 either having a concave form according to Figure 3A, or having a convex form according to Figure 3B, and having a linear surface part 31 joining therewith. Every single lens 26 has an individual form which is either determined empirically or by calculation, namely in such way that in accordance with the the form and/or the direction of the angle of every polygonal or round surface part 30, 31 with respect to the optical axis of the signal lamp the light radiated from the light source is individually directed into specific directions on the basis of user specified orders. Therefore, the LED light is directed according to the predetermined angular intensity distribution due to the angle and position of every polygonal sur-

face. The light radiation is formed such according to the defined curving or bending of the concave or convex surface parts 30 that the predetermined angular intensity distribution is fulfilled. Consequently, as less as possible light is wasted, therefore the efficiency is increased significantly. Moreover, a good uniformity concerning the light density is achieved, as every honeycomb like single lens 26 generates individual the wished angular intensity distribution, wherein additionally also the mixing of colors is generated in each single lens. As a result it is also possible to reduce the number of light means (LEDs) and also to combine or mix light means (LEDs) having different colors, without having noticeable color variations

or noticeable light dots as in prior devices (countable and seeable by light dots on the front lens). In other words, the signal light of the invention appears as a smooth regularly illuminated light area. Furthermore, the geometry of the internal structure of the lens could be designed such that less or even no light is directed to non-wished directions to the external, therefore still increasing the efficiency of the signal lamp.

**[0027]** By combining the afore-said optical features with a further detailed design of the internal lens structure it is further possible to direct the inputting sun light onto the absorbing areas of the form part 14 and the other parts of the housing such that this light does not reach any more into the light means (LEDs) and/or the reflectors correlated with the light means. Therefore, the lens device 6 in addition works with respect to a further reduction of phantom light. For example, anti reflection areas 32 ("phantom light dots") could be formed on the inside or outside of the lens device (by roughing, matting, coloring or printing), and in particular individual for each single lens. With such anti reflection areas 32, reflections stemming from the internal lens structure can be avoided by absorption or divergence. The form, size and position of such anti reflection areas 32 can vary dependent of the position and angle of each single lens within the lens device 6.

**[0028]** As in particular at the edge of the lens device 6 the efficiency decreases due to higher angles and increasingly greater vertical areas, the honeycomb structure may be replaced by a so-called TIR-zone (TIR = Total Internal Reflection). Instead of a light deflection on the surfaces of the polygonal structures, a "total internal reflection" (TIR) may be used within the material itself. Figures 6, 7 and 8 show details of such TIR-zones 36 at the edge regions of the lens device 6.

**[0029]** A specific feature of the present invention is further that the number, the position and the distance of the light means 3 on the circuit board 10 can variable be settled dependent on the user specifications. Furthermore, the position of the circuit board 10 on the basis support 2 can be set with predetermined position limits, in order to optimize the angular intensity distribution of the signal lamp 1. For such purpose, the circuit board 10 has on its contacting surface several prefabricated

pads 33 for contacting the light means or LEDs 3. In the disclosed embodiment (see Figure 4), a number of ten pads 33 are arranged in the form of a triangle. Some of them are used for the contact with the light means, wherein the number and arrangement of the contacted light means 3 depend on the user specified total light power, light performance and light characteristic to be fulfilled by the signal lamp.

**[0030]** The circuit board 10 comprises several prefabricated boreholes 34 for securing the circuit board 10 on the basis support 2 through fastening means like screw connections or pins or other means, and said basis support 2 comprises several holes 35 for engaging said fastening means. The distance between said many holes 35 is rather narrow, in order to allow a geometric variable fixation of the circuit board 10 on the basis support within the plane of the basis support. In addition, there can be provided one or more distance keeper between the circuit board 10 and the basis support 2, in order to have a variable positioning of the light means 3 with respect to the height of the light means 3.

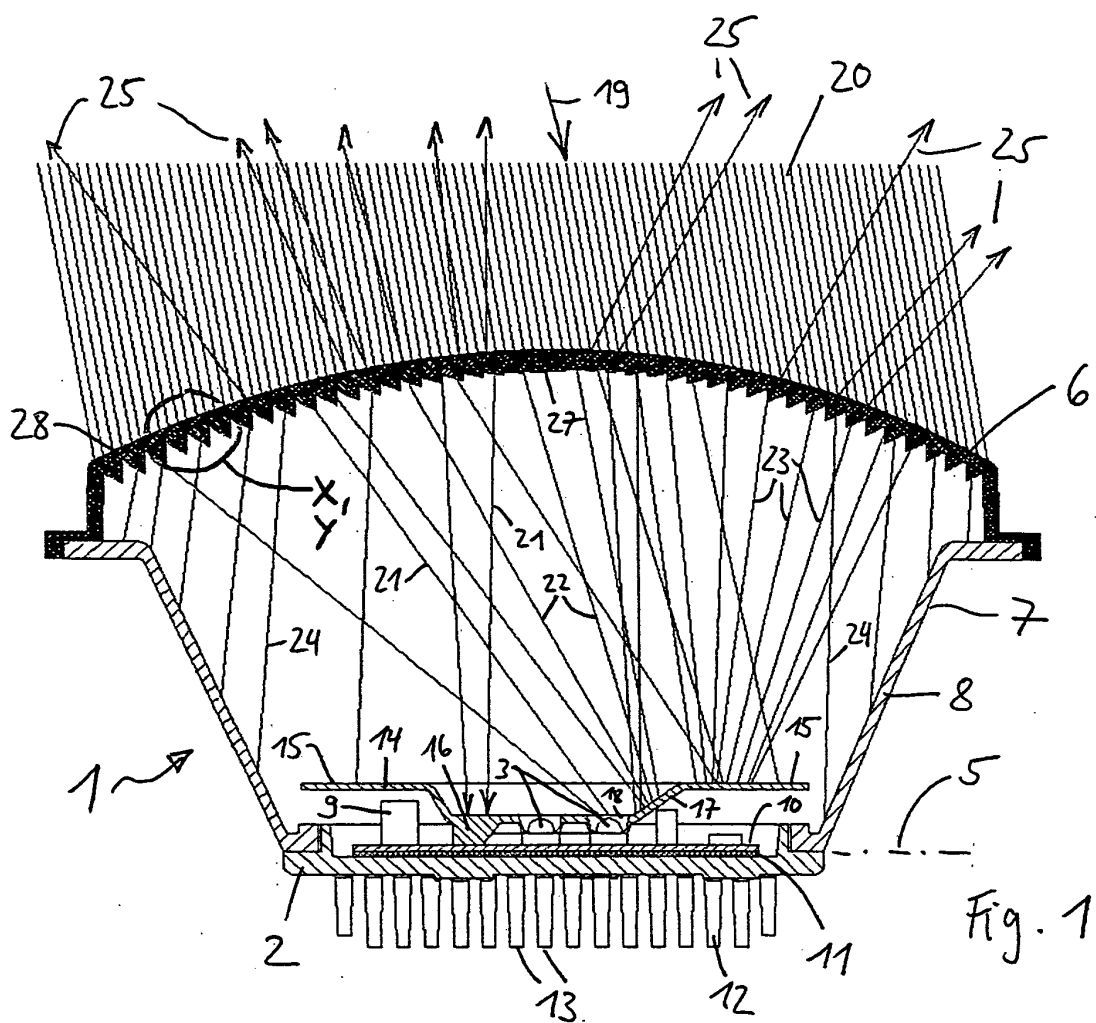
#### Claims

1. Signal lamp with a basis support (2) and with at least one light means (3), preferably two or a few more electric light means (3), which together represent a quasi central source of light, and which are arranged with small distance between each of them on said basis support (2) within a plane (5), such that the area enclosed by said light means (3) has a maximum side value, and with a lens device (6), which is arranged in a predetermined distance in front of the light means (3) such, that said predetermined distance is greater, and especially substantially greater than the maximum side value, **characterized in that**, in case of only one light means (3), the position, and in case of few light means (3), the position and the distances of the light means are adjustable according to user specific variables on the basis support (2).
2. Signal lamp according to claim 1, **characterized by** a circuit board (10) supporting the light means (3), said circuit board comprising on its contact surface area several prefabricated pads for connecting said light means (3).
3. Signal lamp according to claim 1 or 2, **characterized in that** several prefabricated pads are arranged in such way, that any number and arrangement of the light means (3) dependent on the user specified total light power, light performance and light characteristic is fulfilled by said signal lamp.
4. Signal lamp according to any of the previous claims, **characterized in that** said circuit board (10) com-

prises several prefabricated boreholes for securing the circuit board (10) on the basis support (2) through fastening means like screw connections or pins or other means, and said basis support (2) comprises several holes for engaging said fastening means.

5. Signal lamp according to any of the previous claims, **characterized in that** there is provided a distance keeper between the circuit board (10) and the basis support (2) for a variable positioning of the light means (3) with respect to the height of the light means (3).
6. Signal lamp according to any of the previous claims, **characterized in that** the basis support (2) comprises a cooling element (12) on the rear side of said basis support (2), said rear side being on the opposite side of the light means (3).
7. Signal lamp according to any of the previous claims, **characterized in that** said one or few light means (3) and a electric wiring (9) corresponding to a drive means and a performance supply of the light means (3) are arranged on only one circuit board (10), wherein said circuit board (10) is coupled with said cooling element (12) through a heat conducting material (11).
8. Signal lamp according to any of the previous claims, **characterized in that** the cooling element (12) is formed by a passive cooling body or a heat storing element.
9. Signal lamp with a basis support (2) and a light source arranged on the basis support (2), said light source being a central or quasi central light source, and at least forming a spot like light source, and with a lens device (6) which is arranged at a predetermined distance in front of the light source, **characterized in that** the lens device (6) comprises only one single combination lens consisting of a plurality of single lenses, each having differing optical angular intensity distribution.
10. Signal lamp according to any of the previous claims, **characterized in that** the combination lens (6) has a first surface area (27), which is facing the light source and comprises an internal structure, and a second surface area (28), which is curved and turned away with respect to the light source.
11. Signal lamp according to any of the previous claims, **characterized in that** the internal structure of said first surface area (27) of the combination lens (6) is formed by polygonal or round area parts, and is formed especially by 4-or 6-cornered area parts or by circular or oval area parts.

12. Signal lamp according to any of the previous claims, **characterized in that** the radiating light from the light source is distributed in predetermined directions, which are adjustable according to user specific orders, by setting the angle of each polygonal or round area part with respect to the optical axis of the signal lamp. 5
13. Signal lamp according to any of the previous claims, **characterized in that** the combination lens (6) comprises anti reflex areas (32), which are formed differently on the inside or outside of the surface with respect to the shape, the size and the position of said anti reflex areas. 10 15
14. Signal lamp according to any of the previous claims, **characterized in that** the anti reflex areas are formed by roughing, matting, coloring or printing of the lens surface. 20
15. Signal lamp with a basis support (2) and at least one light means (3), preferably two or a few more electric light means (3), which together represent a quasi central light source, and which are arranged with a small distance between them on the basis support (2) within a plane, such that the area enclosed by light means (3) comprises a maximum side value, and with a lens device (6), which is arranged in a predetermined distance in front of the light means (3) such, that said predetermined distance is greater, and especially substantially greater than the maximum side value, **characterized in that** the one or few light means (3) are arranged on one single circuit board (10), said circuit board housing also the electric circuits for controlling and power supplying said light means, and comprising a form part (14) fabricated of a light absorbing material, preferably synthetic material, said form part covering the circuit board (10) completely. 25 30 35 40
16. Signal lamp according to claim 15, **characterized in that** said form part (14) comprises a wing part (15) extended to the outside, a middle part (16) and a sloped wall part (17) coupling the wing part (15) and the middle part (16), said parts (15, 16, 17) of the form part (14) screening all reflective parts of the basis support (2) or of the circuit board (10) against non wished light reflections. 45 50
17. Signal lamp according to claim 16, **characterized in that** the form part (14) comprises drill holes or openings (18), in which said light means (3) are inserted. 55
18. Signal lamp according to any of the previous claims, **characterized in that** the light means (3) are luminescent diodes, especially high power luminescent diodes.



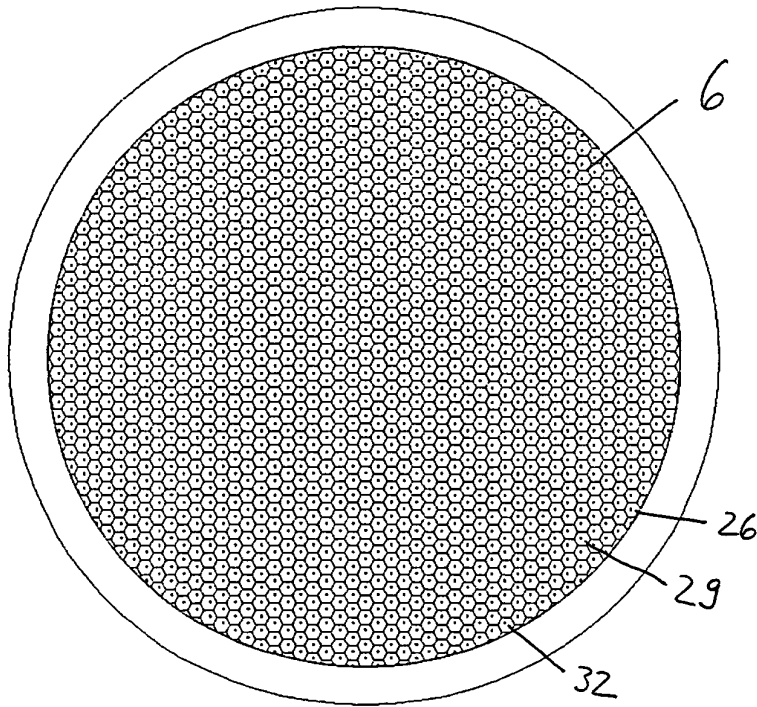


Fig. 2

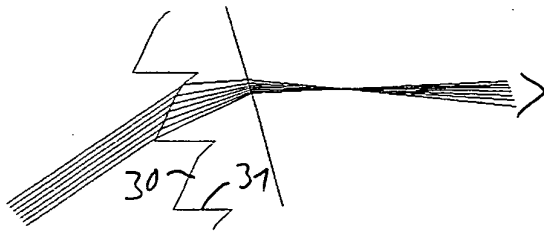


Fig. 3A

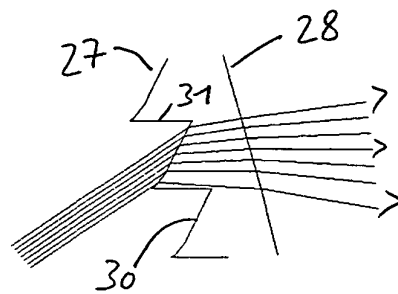


Fig 3B



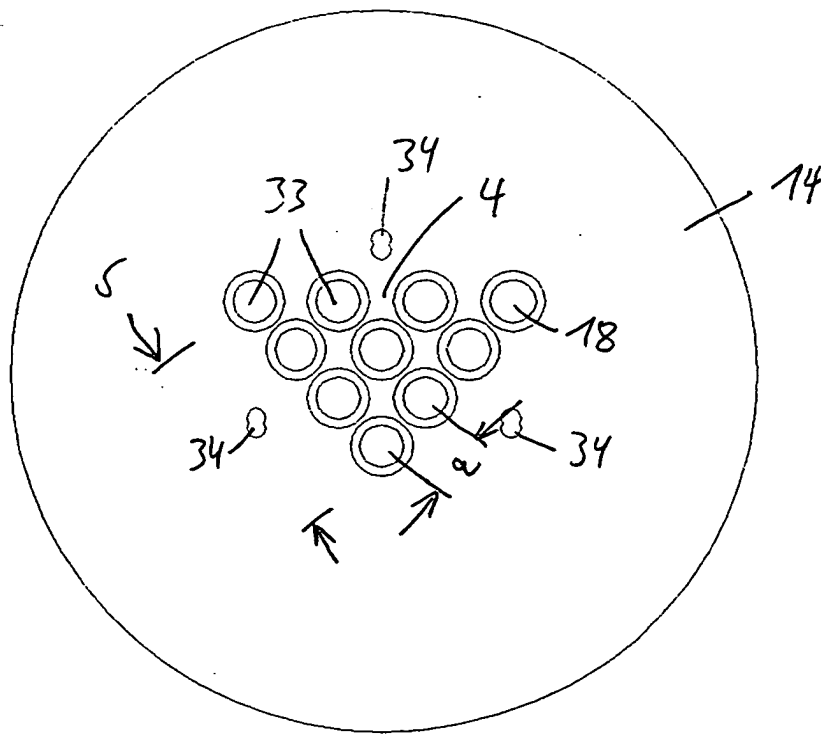


Fig. 4

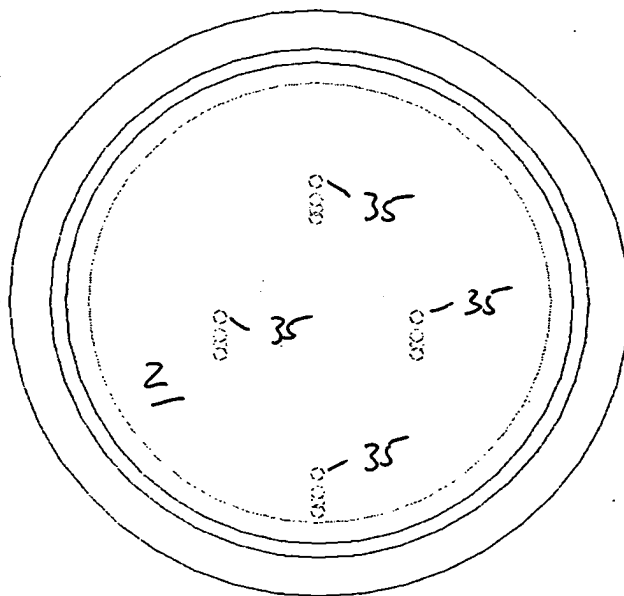


Fig. 5



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# EUROPEAN SEARCH REPORT

Application Number  
EP 04 01 3321

| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                                                           |                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                       |                                              |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|
| Category                                                                                                                                                                                                                                                      | Citation of document with indication, where appropriate, of relevant passages                                                                                                               | Relevant to claim                                                                                                                                                                                                                                                                     | CLASSIFICATION OF THE APPLICATION (Int.Cl.7) |
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| A                                                                                                                                                                                                                                                             | US 2002/085390 A1 (KIYOMOTO HIRONOBU ET AL)<br>4 July 2002 (2002-07-04)<br>* paragraph [0214] *<br>-----                                                                                    | 1                                                                                                                                                                                                                                                                                     |                                              |
| A                                                                                                                                                                                                                                                             | US 6 323 781 B1 (HUTCHISON MICHAEL C)<br>27 November 2001 (2001-11-27)<br>* column 1, lines 20-25 *<br>* column 3, lines 29-32 *<br>-----                                                   | 1                                                                                                                                                                                                                                                                                     |                                              |
| A                                                                                                                                                                                                                                                             | US 2003/174501 A1 (MARTINEAU PATRICK)<br>18 September 2003 (2003-09-18)<br>* figure 2a *<br>* page 1, paragraphs 5,6,8 *<br>* page 2, paragraphs 55,56 *<br>-----                           | 1                                                                                                                                                                                                                                                                                     |                                              |
| A                                                                                                                                                                                                                                                             | US 2002/117954 A1 (NAGANO MASAMITSU ET AL)<br>29 August 2002 (2002-08-29)<br>* figure 3 *<br>* page 1, columns 7,9 *<br>* page 2, paragraph 40 *<br>* page 3, paragraph 42 *<br>-----       | 1                                                                                                                                                                                                                                                                                     |                                              |
| The present search report has been drawn up for all claims                                                                                                                                                                                                    |                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                       |                                              |
| Place of search<br><b>Munich</b>                                                                                                                                                                                                                              |                                                                                                                                                                                             | Date of completion of the search<br><b>8 March 2005</b>                                                                                                                                                                                                                               | Examiner<br><b>Coffa, A</b>                  |
| <b>CATEGORY OF CITED DOCUMENTS</b><br>X : particularly relevant if taken alone<br>Y : particularly relevant if combined with another document of the same category<br>A : technological background<br>O : non-written disclosure<br>P : intermediate document |                                                                                                                                                                                             | T : theory or principle underlying the invention<br>E : earlier patent document, but published on, or after the filing date<br>D : document cited in the application<br>L : document cited for other reasons<br>.....<br>& : member of the same patent family, corresponding document |                                              |

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT  
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.  
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