(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 796 778 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
29.10.2014 Bulletin 2014/44

(21) Application number: **13165557.3**

(22) Date of filing: **26.04.2013**

(51) Int Cl.:
F21V 7/00 *(2006.01)* ***F21V 14/04*** *(2006.01)*
F21V 5/00 *(2006.01)* *F21V 7/04* *(2006.01)*
F21V 7/06 *(2006.01)* *F21V 7/07* *(2006.01)*
F21V 7/08 *(2006.01)* *F21V 7/09* *(2006.01)*
F21V 14/06 *(2006.01)* *F21V 21/22* *(2006.01)*
F21V 8/00 *(2006.01)*

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

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(54) **Lighting system**

(57) The invention related to a lighting system comprising a light source (4), at least one first optical element (1) which is designed to receive light from the light source (4), at least one second optical element (2) with the second optical element (2) being movably arranged with respect to the first optical element (1) between an interference position and a rest position wherein the second optical element (2) receives light from the light source (4) within the interference position and the first optical element (1) receives light from the light source (1) with the second optical element (2) being in its rest position, wherein the first optical element (1) is in a fixed position to the light source (4) and the second optical element (2) is arranged between the light source (4) and the first optical element (1).

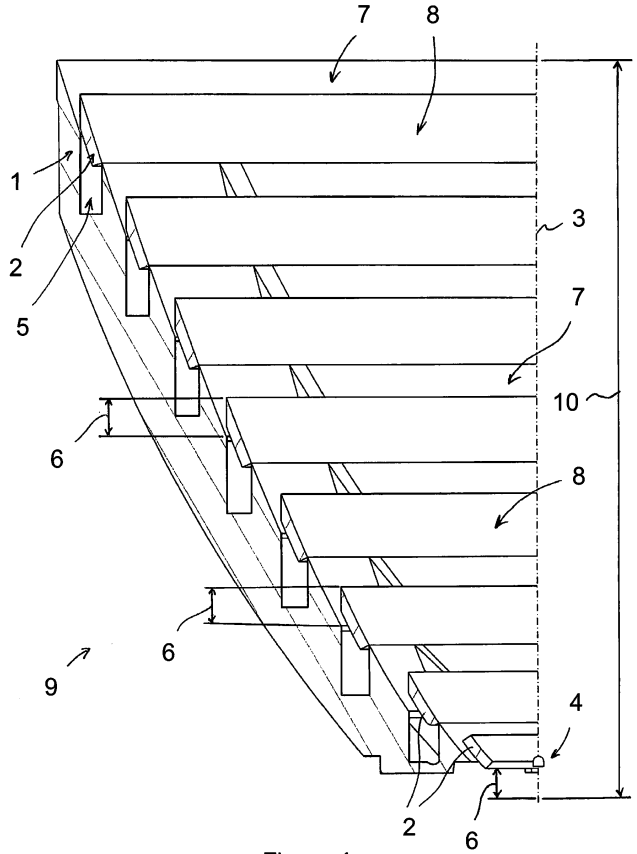

Figure 4

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Description

Field of the invention

[0001] The present patent application relates to a lighting system comprising a light source, at least one first optical element which is designed to receive light from the light source, at least one second optical element with the second optical element being movably arranged with respect to the first optical element between an interference position and a rest position wherein the second optical element receives light from the light source within the interference position and the first optical element receives light from the light source with the second optical element being in its rest position.

[0002] High power light sources such as light emitting diodes are used in many applications. Some of these applications such as flash lights, spot lights or adjustable light systems call for the ability to focus or change the size of a projected light spot. One commonly used lighting system with focusing features utilizes a single reflector as an optical element. The reflector can be moved with respect to the light source in order to focus or to change the size of the light spot. Moreover, a lighting system with two reflectors and a light source is known from the US patent 8,118,451 B2. An inner reflector which is in a fixed position to the light source is held moveably with respect to an outer reflector. Depending on the relative position of the inner reflector and the outer reflector the light emitted by the light source is either received by the inner reflector solely or it is received by both the inner reflector and the outer reflector. The lighting system provides a narrow beam if both the inner reflector and the outer reflector receive the light emitted by the light source. A wide beam is provided if the light emitted by the light source is only received by the inner reflector.

Summary of the invention

[0003] The problem to be solved in this invention is to realize a small size lighting system with focusing features and to reduce the moving distance of moveable optical elements of the lighting system.

[0004] To achieve this object the invention is characterized in that the first optical element is in a fixed position to the light source and that the second optical element is arranged between the light source and the first optical element.

[0005] The particular benefit of the invention is that a small size lighting system is provided with two optical elements being moveably arranged to each other. The first optical element and the light source of the lighting system are in fixed position to each other and a moveable second optical element is arranged between the first optical element and the light source. The second optical element is moveable between an interference position and a rest position. If the second optical element is in its interference position it receives light from the light source.

[0006] The invention allows changing an optical strategy of the lighting system by small movements of the second optical element. With this invention it is possible to realize an optical zoom for spot lights, flash lights or the like. As the focusing feature is realized at low costs it enables low price products. In addition the focusing feature is highly variable as the second optical element can be moved to various intermediate positions with each intermediate position allowing a different optical strategy by the same product. This reduces product variety in the production and allows the use of the same product for several applications.

[0007] The second optical element can be arranged in at least one intermediate position between the rest position and interference position. In the intermediate position of the second optical element light emitted by the light source can be received by both the first optical element and the second optical element. The first optical element may also receive light from the second optical if the second optical element is designed as a light guide which transmits at least a part of the light received by the light source.

[0008] According to a preferred embodiment of this inventions a majority of first optical elements and a majority of second optical elements is provided with the first optical elements and/or the second optical elements being arranged in a step like arrangement wherein the radial dimensions or the diameter of the first optical elements and/or of the second optical elements increases with increasing axial distance between the light source and the several optical elements. By providing a step like arrangement the light emitted by the light source can be received by the majority of optical elements. Each optical element can have an individual optical characteristic in order to realize a desired and variable beam characteristic of the lighting system. For example a spreading angle of the majority of the first optical elements can spread between -/+ 4° while the spreading angle of the second optical elements spreads between -/+ 35°. For example the spreading angle of the first optical elements can smoothly increase from +/- 5° to +/- 12.5° while the spreading angle of the second optical elements smoothly decreases from +/-35° to +/-15°. This allows a smooth transition between different light strategies realized by the lighting system.

[0009] The first optical elements and the second optical elements of the lighting system can be built as reflector type optical elements or as refracting optical elements. A surface of the optical elements can be formed as a free form surface which allows a very individual and sophisticated optical strategy. The surface may provide a majority of segments with each segment having its own spreading angle or with each segment being formed as a free form surface.

[0010] In a further embodiment of this invention an optical characteristic of the at least one second optical element is adjusted to an optical characteristic of the at least one first optical element in such a way that a beam

with a first characteristic is formed with the second optical element being in the rest position and a beam with a second characteristic is formed with second optical element being in the interference position. As an example of the different beam characteristics the lighting systems may provide a wide beam and a large-scale light spot with the at least one second optical element being in its rest position, while the same lighting system may provide a narrow beam and a small-size light spot with the at least one second optical element being in its interference position. Depending on the position of the moveable second optical element the beam characteristic of the lighting system can be changed from narrow to wide. All intermediate positions of the moveable second optical element can provide a beam characteristic between the wide beam and the narrow beam. Within this example the optical characteristic of the first optical element may be affected by a first spreading angle while the optical characteristic of the second optical element may be affected by a second spreading angle.

[0011] According to a further embodiment of the invention the surfaces of the optical elements have different optical properties. E. g. the surface of the first optical element may form a cold mirror designed for reflecting the entire visible light spectrum and allowing infrared light to pass while the surface of the second optical element might be designed as a hot mirror reflecting infrared light and allowing visible light to pass. E. g. the different optical properties of the surfaces may allow for a change of the light colour.

[0012] According to further embodiment of the invention the majority of first optical elements and the majority of second optical elements are comprised with each second optical element being positioned between two first optical elements or between one first optical element and the light source. The lighting system can be built advantageously small and small moving distances for the second optical elements can be provided with the second optical elements being positioned between two first optical elements or one second optical element and the light source.

[0013] According to a further embodiment of the invention a gap is built between two adjacent first optical elements. A second optical element which is arranged between the two adjacent first optical elements passes through the gap when being moved from the rest position to the interference position and reverse. By providing the gap and moving the second optical elements through the gap the second optical element can be located behind one of the two adjacent first optical elements in its rest position and it can be located in front of the second adjacent first optical element in its interference position. Light emitted from the light source can therefore directly be received by the first optical elements if the second optical elements are in its rest position while the second optical elements received light emitted by the light source in its interference position.

[0014] If the second optical element is built as a refracting element the light received by the second optical elements first can pass through the second optical element and can be transmitted to the first optical elements. If the second optical elements are built as reflector type optical elements the light received by the second optical elements in its interference position is not received by the first optical elements located behind the second optical elements.

[0015] Further advantages of this invention are disclosed in the subclaims.

Brief description of the drawings

[0016] The present invention will become more fully understood from the detailed description given hereinbelow and the accompanying drawings which are given by way of illustration only, and thus, are not limitive to the present invention.

[0017] In the drawings:

Figure 1 is a side view of a lighting system;

Figure 2 is a view into the lighting system of figure 1;

Figure 3 shows the partial section through the lighting system of figure 1 with a majority of second optical elements being in the rest position;

Figure 4 shows the partial section through the lighting system of figure 1 with a majority of second optical elements being in the interference position;

Figure 5 shows a raytrace with the second optical elements being in the rest position; and

Figure 6 shows the raytrace with the second optical elements being in the interference position.

Detailed description of the drawings

[0018] Figures 1 and 2 show a reflector type lighting system with a majority of first optical elements 1 and a majority of second optical elements 2 forming the reflector 9 of the lighting system. The optical elements 1, 2 are built as rotationally symmetric optical elements. All optical elements 1, 2 are in a coaxial arrangement with respect to an optical axle 3 of the lighting system.

[0019] A surface 7 of the first optical elements 1 and a surface 8 of the second optical elements 2 define a parabolic surface section of the reflector 9 with a high power light source 4 being arranged in the origin of the parabolic reflector surfaces 7, 8.

[0020] The second optical elements 2 are moveable arranged with respect to the first optical elements 1 and the light source 4. The moveable arrangement of the second optical elements 2 allows the lighting system to be used as a spot light or flash light with focusing feature.

[0021] Figures 3 and 4 show the second optical elements 2 in the rest position and the interference position respectively. The optical elements 1, 2 are in a step like arrangement with increasing axial distance and constant radial distance between adjacent first optical elements 1.

[0022] As it becomes clear the moving distance 6 of the second optical element 2 is very small compared to the height of the reflector 9. E.g. the moving distance 6 is less than one tenth of the axial height 10 of the reflector 9.

[0023] The second optical element 2 is allocated to a gap 5 built between two adjacent first optical elements 1. The spacing of the first optical elements 1 and the second optical elements 2 in both axial and radial direction is directly linked to the size and position of the reflecting surfaces 7, 8 of the optical element 1, 2. Light emitted by the light source 4 is completely received by the first optical elements 1 with the second optical elements 2 being in the rest position while the light is completely received by the second optical elements 2 if these are in the interference position.

[0024] As shown in figures 5 and 6 the second optical elements 2 are located in the gaps 5 between two first optical elements 1 or between the light source 4 and the first optical element 1 which is nearest to the light source 4 in the rest position. As a result all but the first second optical element 2 are located behind the first optical element 1 with the first optical element 1 being located between the light source 4 and the second optical element 2. Light emitted by the light source 4 does not receive the reflecting surface 8 of the second optical element 2 but only the reflecting surface 7 of the allocated first optical element 1. In the interference position the second optical element 2 is located in front of the first optical element 1. Light emitted by the light source 4 is received by the second optical element 2 while the first optical element 1 located behind the second optical element 2 does not receive light.

[0025] As the optical measurement of the first optical elements 1 and the second optical elements 2 are different, different light strategies can be realized by the lighting system depending on the position of the second optical element 2. With the second optical element 2 being in its interference position a narrow beam is formed and a small projected light spot is provided. If the second optical element 2 is in its rest position the light emitted by the light source 4 is received by the first optical element 1 and a wide beam is formed.

[0026] If the second optical element 2 is in an intermediate position between the rest position and the interference position both the first optical element 1 and the second optical element 2 receive light from the light source 4. The projected light spot has an intermediate size and therefore the optical strategy can be varied in a large scale and the lighting system can be used for several different lighting tasks. The second optical elements 2 can be moved individually or all at the same time. The individual movement of the second optical elements 2 allows additional optical strategies.

[0027] According to an alternative embodiment of the invention not shown in the figures with at least one moveable optical element 2 the ratio of the moving distance 6 and the axial height 10 is within the range of 0.01 to 0.4. The light source 4 is in a fixed position with respect to the at least one first optical element 1. The at least one second optical element 2 is a position between the light source 4 and the at least one first optical element 1. As a basic rule the moving distance 6 decreases with the number of moveable optical elements 2 increasing. The moving distance 6 increases if only a single second optical element 2 or a few second optical elements 2 are provided.

[0028] According to a further embodiment of the invention the moving distance 6 of the second optical elements 2 can vary. E. g. the second optical element 2 which is located next to the light source 4 may have the smallest moving distance 6 while the moving distance 6 increases for optical elements 2 which have a larger distance to the light source 4. E. g. each second optical element 2 can have an individual moving distance 6.

[0029] Identical components and component functions are denoted by identical reference signs.

List of reference numbers

1	first optical element
2	second optical element
3	optical axle
4	light source
5	gap
6	moving distance
7	optical surface of first optical element
8	optical surface of second optical element
9	reflector
10	reflector height

Claims

1. Lighting system comprising

- a light source (4),
- at least one first optical element (1) which is designed to receive light from the light source (4), and
- at least one second optical element (2) with the second optical element (2) being movably arranged with respect to the first optical element (1) between an interference position and a rest position

wherein the second optical element (2) receives light from the light source (4) in its interference position and the first optical element (1) receives light from the light source (4) with the second optical element (2) being in its rest position,

characterized in that the first optical element (1) is in a fixed position to the light source (4) and that the second optical element (2) is arranged between the light source (4) and the first optical element (1).

2. Lighting system comprising

- a light source (4),
- at least one first optical element (1) which is designed to receive light from the light source (4), and
- at least one second optical element (2) with the second optical element (2) being movably arranged with respect to the first optical element (1) between an interference position and a rest position

wherein the second optical element (2) receives light from the light source (4) in its interference position and/or in an intermediate position which is located between the rest position and the interference position,

wherein the first optical element (1) receives light from the light source (4) and/or from the second optical element (2) with the second optical element (2) being in its rest position and/or in the at least one intermediate position,

characterized in that the first optical element (1) is in a fixed position to the light source (4) and that the second optical element (2) is arranged between the light source (4) and the first optical element (1).

3. Lighting system of claim 1 or 2 **characterized in that** a majority of first optical elements (1) and/or a majority of second optical elements (2) is provided with the first optical elements (1) and/or the second optical elements (2) being arranged in a step like arrangement, wherein the radial dimensions of the first optical elements (1) and/or the second optical elements (2) increases with increasing axial distance between the light source (4) and the first optical elements (1) and/or the second optical elements (2).

4. Lighting system of one of the claims 1 to 3 **characterized in that** an optical characteristic of the at least one second optical element (2) is adjusted to an optical characteristic of the at least one first optical element (1) in such a way that a beam with a first characteristic is formed with the second optical element (2) being in its rest position and a beam with a second characteristic differing from the first characteristic is formed with the second optical element (2) being in its interference position.

5. Lighting system of one of the claims 1 to 4 **characterized in that** the majority of first optical elements (1) and that the majority of second optical elements (2) is comprised with each second optical element (2) being positioned between two first optical elements (1) and/or between one first optical element (1) and the light source (4).

6. Lighting system of one of the claims 1 to 5 **characterized in that** a gap (5) is formed between two adjacent first optical elements (1) and that the second optical element (2) which is arranged between the two adjacent first optical elements (1) passes through the gap (5) when being moved from the rest position to the interference position and reverse.

7. Lighting system of one of the claims 1 to 6 **characterized in that** the first optical element (1) and/or the second optical element (2) are built as reflector type optical elements and/or refracting elements.

8. Lighting system of one of the claims 1 to 7 **characterized in that** a surface (7) of the first optical element (1) and/or a surface (8) of the second optical element (2) is formed as a free form surface and/or as a segmented surface and/or as a pillow-shaped surface, and/or that the surfaces (7, 8) of the optical elements (1, 2) have different optical properties.

9. Lighting system of one of the claims 1 to 8 **characterized in that** the majority of first optical elements (1) and/or the majority of second optical elements (2) form a parabolic reflector (9) and/or a hyperbolic reflector (9) and/or a ball-shaped reflector (9) and/or an elliptical-shaped reflector (9) and/or cone-shaped reflector (9) and/or that the light source (4) is arranged in the origin of the reflector (9).

10. Lighting system of one of the claims 1 to 9 **characterized in that** the first optical element (1) and/or the second optical element (2) are formed as rotationally symmetric optical elements (1, 2) and/or circular designed optical elements (1, 2) and/or squared optical elements (1, 2) and/or hexagonal optical elements (1, 2) and/or as a linear optical element (1, 2).

11. Lighting system of one of the claims 1 to 10 **characterized in that** the first optical element (1) and the second optical element (2) are arranged coaxial to each other and/or that the light source (4) is coaxially arranged with respect to the first optical element (1) and/or the second optical element (2).

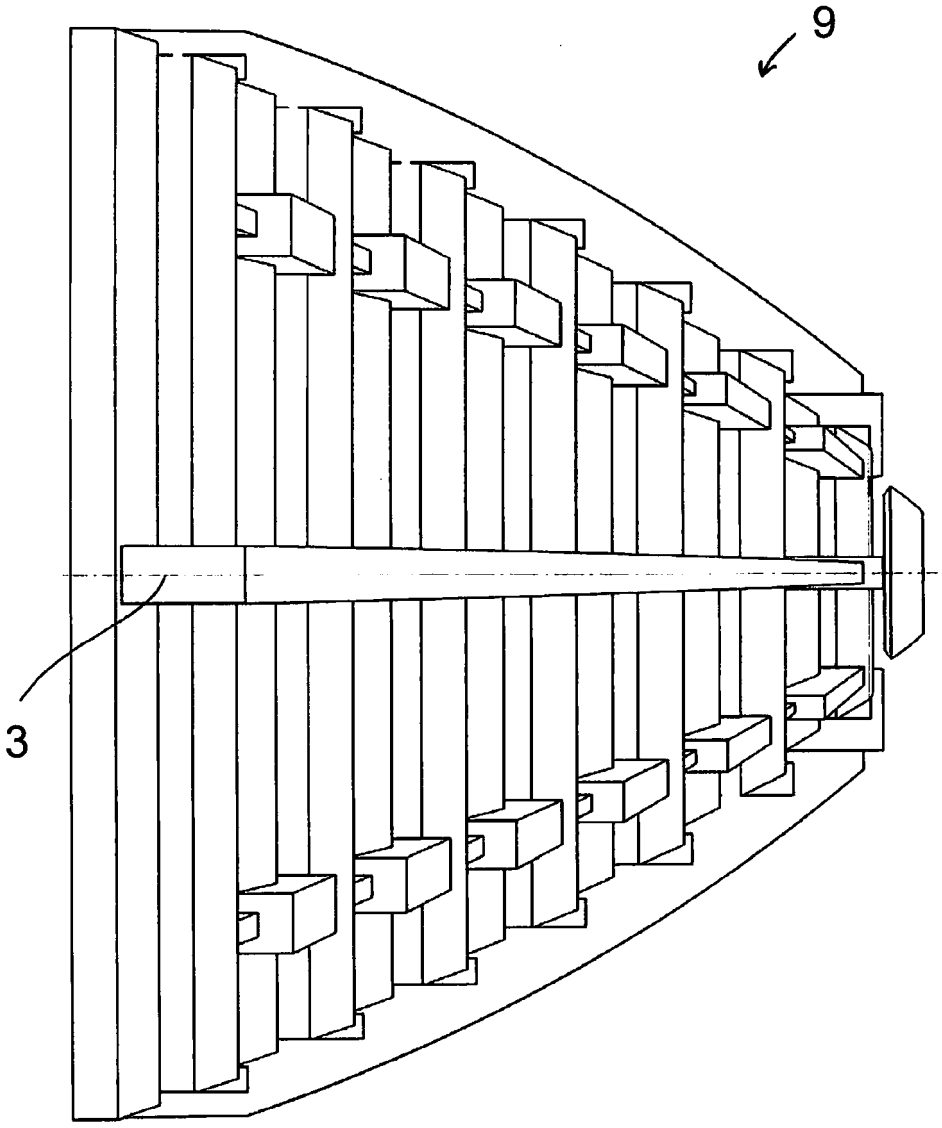

Figure 1

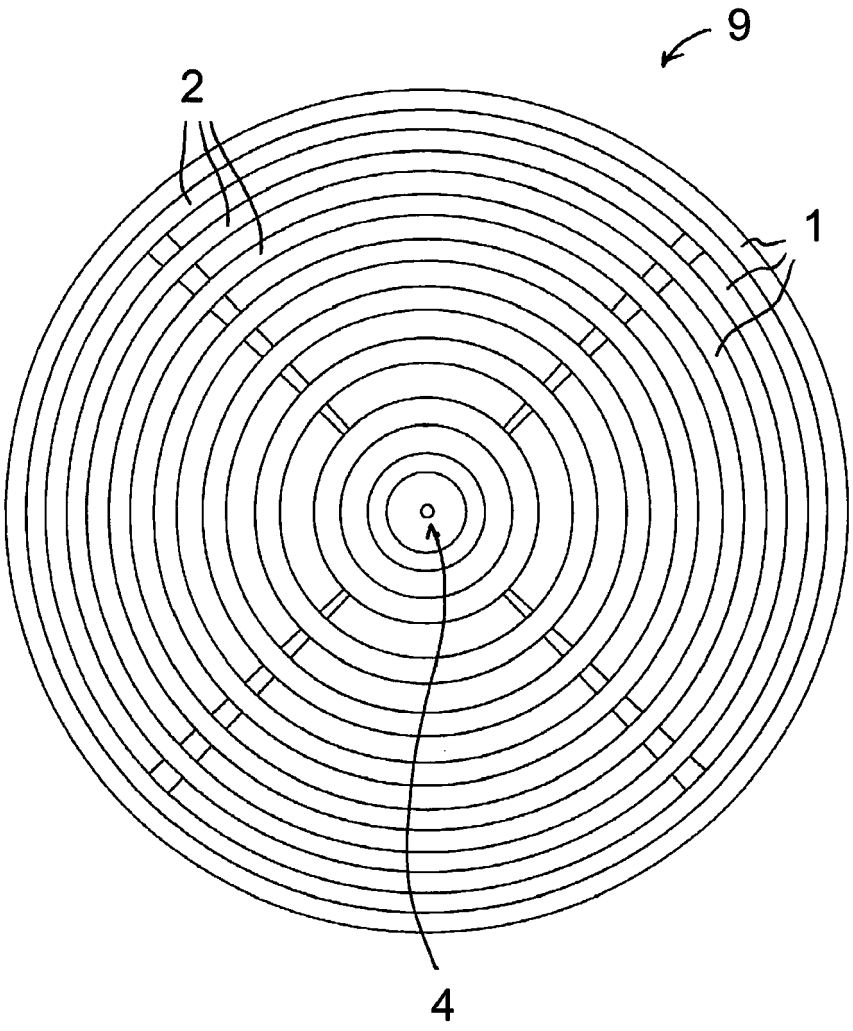

Figure 2

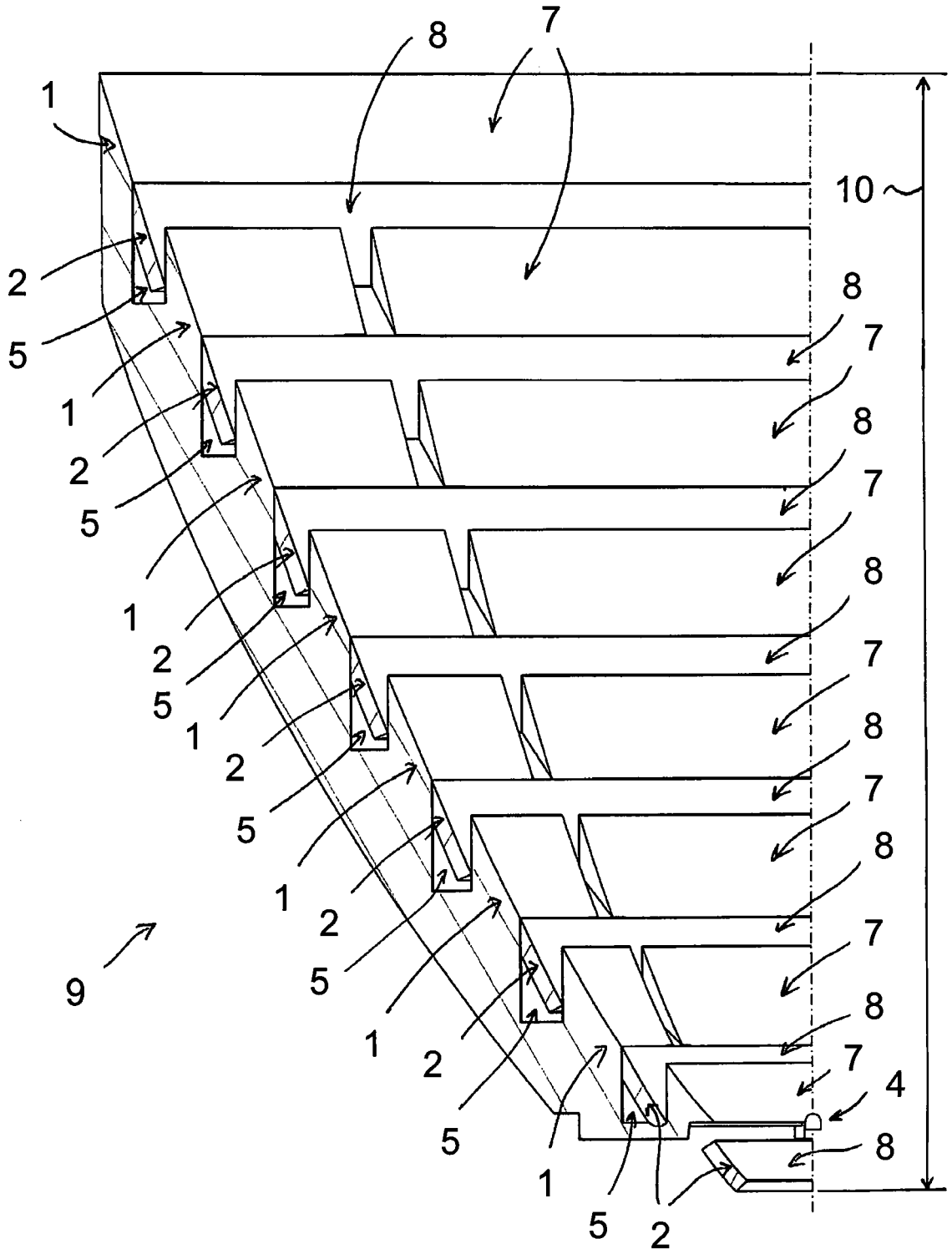

Figure 3

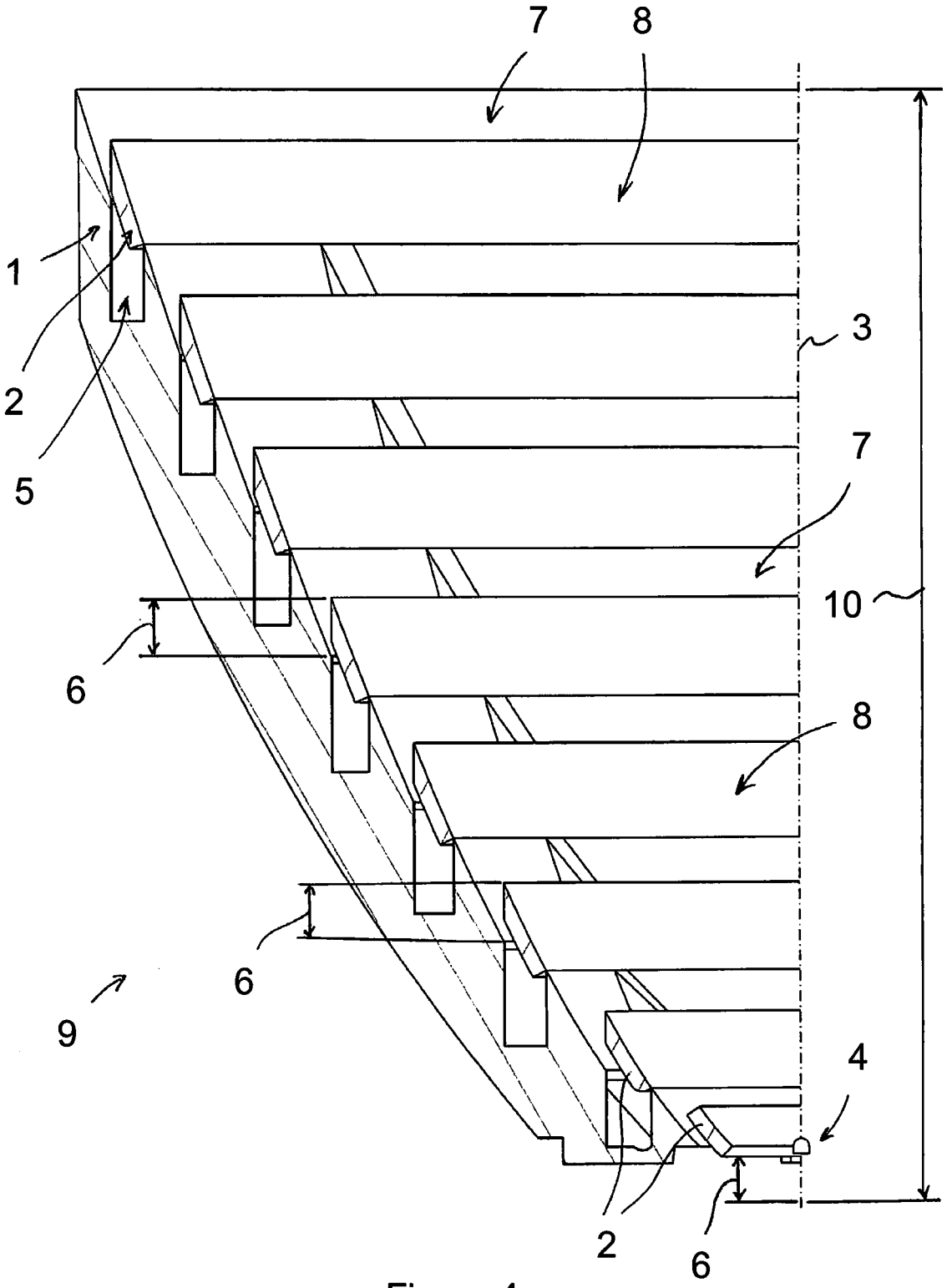

Figure 4

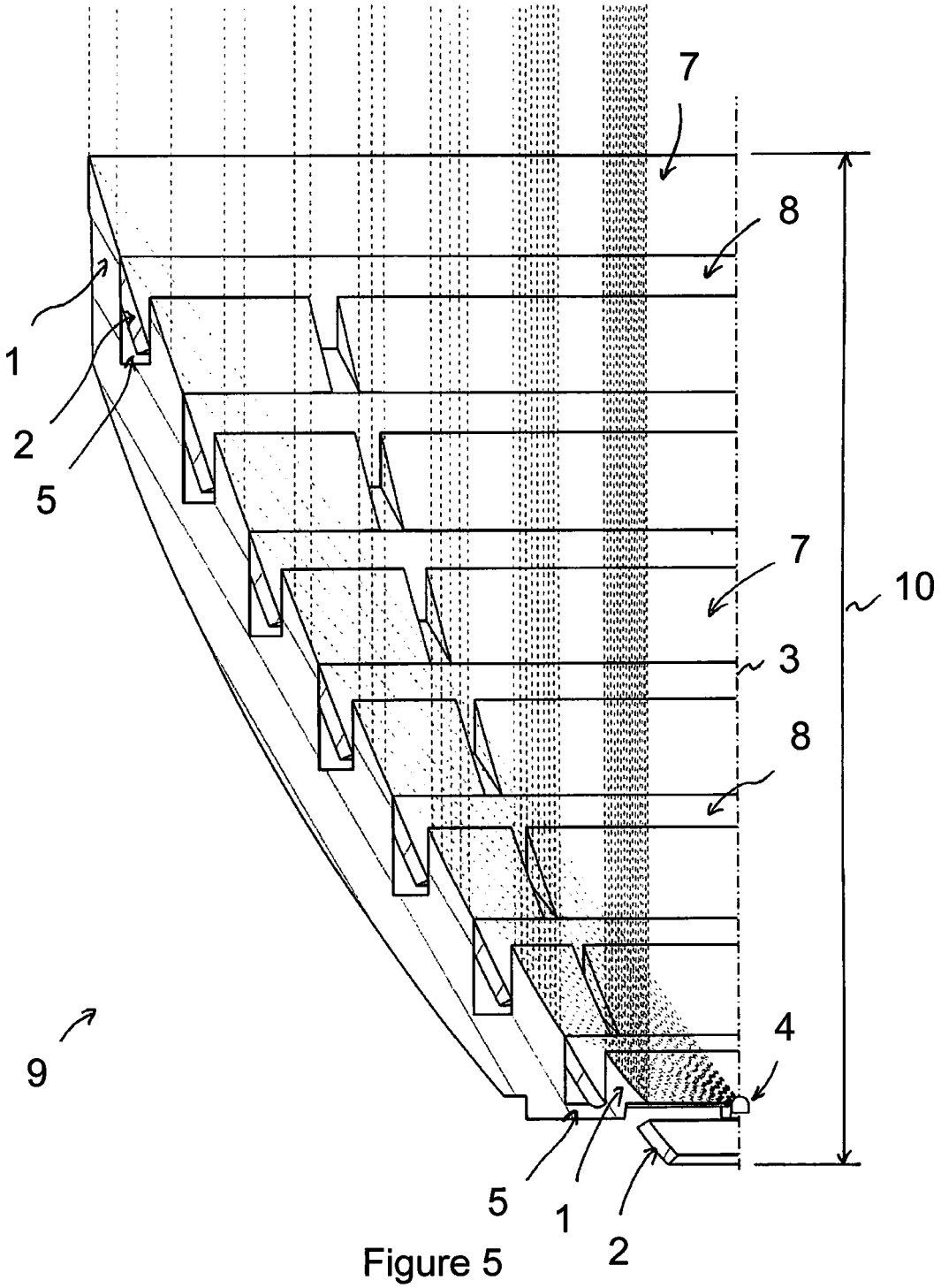

Figure 5

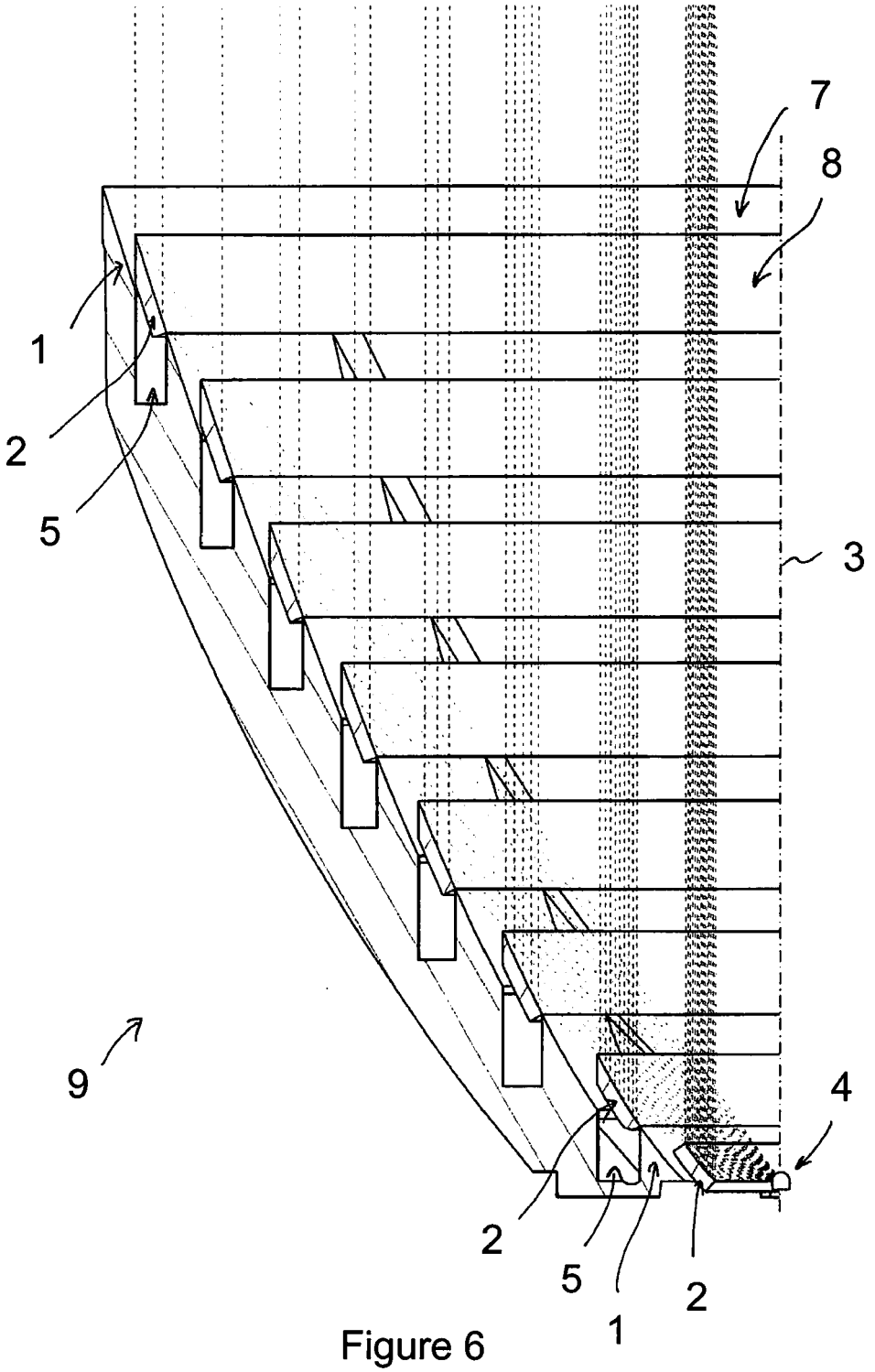

Figure 6

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EUROPEAN SEARCH REPORT

Application Number
EP 13 16 5557

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X A	EP 1 452 797 A1 (CATEYE CO LTD [JP]) 1 September 2004 (2004-09-01) * paragraphs [0026] - [0042]; figures 1-9 * -----	1,2,4, 7-11 3,5,6	INV. F21V7/00 F21V14/04 ADD. F21V5/00 F21V7/04 F21V7/06 F21V7/07 F21V7/08 F21V7/09 F21V14/06 F21V21/22 F21V8/00
X A	EP 0 974 786 A2 (VOLKSWAGEN AG [DE]) 26 January 2000 (2000-01-26) * paragraphs [0018] - [0021]; figure 1 * -----	1,2,4, 7-11 3,5,6	
A	EP 2 428 727 A1 (JORDAN REFLEKTOREN GMBH & CO KG [DE]) 14 March 2012 (2012-03-14) * the whole document * -----	9	

TECHNICAL FIELDS SEARCHED (IPC)
F21V

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	25 June 2013	Menn, Patrick

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25-06-2013

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1452797 A1	01-09-2004	CA 2458727 A1	25-08-2004
		CN 1525098 A	01-09-2004
		DE 602004000308 T2	10-08-2006
		DK 1452797 T3	15-05-2006
		EP 1452797 A1	01-09-2004
		HK 1067403 A1	29-06-2007
		JP 2004259541 A	16-09-2004
		TW I297758 B	11-06-2008
		US 2004165388 A1	26-08-2004
EP 0974786 A2	26-01-2000	AT 336692 T	15-09-2006
		DE 19832466 A1	17-02-2000
		EP 0974786 A2	26-01-2000
EP 2428727 A1	14-03-2012	NONE	

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Patent documents cited in the description

- US 8118451 B2 **[0002]**