

Optical System comprising a Light Guide Element and a joined body being materially connected to the Light Guide Element

Description

The present invention relates to an Optical System comprising a light guide element and a joined functional body being materially connected to the light guide element. Further, the invention is directed to a method for providing such an optical system.

PRIOR ART

DE 10 2010 021 937 A1 discloses an optical system comprising a light guide element and a functional body, whereas the functional body is materially connected to the light guide element, and whereas the functional body forms another light guide element. As an example, the light guide element forms a low beam module, and the functional body forms a high beam unit, whereas both light modules are joined to each other by means of a materially connection, e.g. by means of a glue connection. The surface which is in contact with the functional body must feature high accuracy and a high optical quality in order to avoid an influence on the function of the light guide element. In particular, when the light passes the glued joint, a high optical quality is needed.

DISCLOSURE OF INVENTION

The object of the invention is the advancement of an optical system comprising a light guide element and comprising at least one functional body which is joined to the light guide element, wherein the functional body is joined to the light guide element by means of a material connection, and wherein the joint connection between the functional body and the light guide element features a high quality. In particular, the precision accuracy of the functional body relative to the light guide element has to be high, moreover it is an objective of the invention to provide a joint connection with a high optical quality, when light passes the joint connection, in particular from the light guide element into the functional body or from the functional body into the light guide element.

This object is achieved by an optical system according to the preamble of claim 1 and by a method for providing such an optical system according to the preamble of claim 13 in conjunction with the relevant characterising features. Advantages and preferred embodiments of the invention are identified in the dependent claims.

The invention comprises the technical teaching that the joint connection of the functional body to the light guide element comprises a bonding joint.

The material connection between the light guide element and the functional body, which is a bonding joint according to the invention, meets the object of the invention and provides a high position accuracy of the functional body relative to the light guide element as well as a high optical quality of the materially joined connection.

A bonding process is based on a previous activation of the surface by means of chemical reactive groups on the surface which may react with each other when they are influenced by temperature and pressure. By means of this reaction permanent joint connections are built between the surfaces which are joined to each other with the connections being formed at a molecular level, wherein an influence to the joined partners in general does not occur. In particular, a bonding joint forms an optical connection which is optical failure free between both materials, wherein the activation of the surface may be performed in particular by means of a plasma activation or by means of a so-called corona-treatment. In the present case, either the surface of the light guide element or the surface of the functional body can be activated, wherein in particular both of the bonding surfaces which have to be joined together can be activated.

The special advantage of the invention can be seen in a transition between the light guide element and the functional body of high optical quality, so that in particular in high value optical systems light guide elements can be joint to a functional body by means of a bonding process, without an increased effort for retain a high optical quality of the light guide element.

Advantageously, the light guide element features a glass material or a silicone material. It is also possible that the functional body comprises a silicone material. Glass and/or silicone are bondable materials so that the bonding process for producing the bonding compound between the light guide element and the functional body can be provided in a simple manner and without elaborate preparations.

Moreover, it is possible that the light guide element comprises a synthetic or plastic material, wherein a bonding surface of the light guide element which is in contact with the functional body comprises a bondable coating. The bondable coating can be activated accordingly, so that the bonding process can consequently also be carried out with a synthetic or plastic material of the light guide element which is not bondable per se. As a result, optical systems can be produced with a light guide element made of a synthetic or plastic material and with a functional body made of, for example, glass or silicone. Even the functional body can be provided with a bondable coating so that the bonding process can also be carried out, although both the light guide element and the functional body itself comprise no bondable material.

Several different functions can be assigned to the functional body. For example, the light guide element can feature a main extension direction, whereas the functional body is formed as an enclosing element in order to at least partly enclose the light guide element. Such enclosing elements generally form an enclosure for the light guide element with or without its own optical function, i.e. the enclosing element may be transparent or nontransparent. For example, the enclosing element can enclose the light guide element in a U-shape and at the same time serve for fastening the light guide element, for example, in a vehicle's headlight or rear light. For this purpose, the enclosing element can consequently take over further functions by means of corresponding protrusions. In particular, there is the possibility of assigning an optical function to the transition of the light guide element into the functional body, i.e. to the bonding joint, for example for reflection of light which is guided through the light guide element.

According to a further variant of the functional body, the functional body is designed as a light incoupling body or a light outcoupling body, and the functional body is for example arranged on the end face of the light guide element in the main extension direction. The functional body can be shaped, for example, in a parabolic, funnel-like or other manner and deviate from the cross-sectional shape of the light guide element. In particular, the functional body can in this case be embodied as a light incoupling body for the arrangement to semiconductor light sources in order to finally couple the light into the light guide element. The functional body thus forms a kind of intermediate element between the semiconductor light sources and the actual light guide element. Consequently, the functional body can be positioned laterally of the main extension direction or - in the main extension direction - on the front side of the light guide element.

According to yet another variant, the functional body forms a beam forming body and comprises for example an optical structure for beam shaping. Thus, there is the possibility of providing an easy producible light guide element for example, and a complex optical structure can be introduced into the beam forming body which for example comprises a material that can be easily processed. Thus, for example, the light guide element can be made of glass or plastic, and a fine and very accurate optical structure can be formed on the beam forming body which is formed by the functional body and which is connected to the light guide element via a bonding joint.

According to a preferred embodiment, the functional body is applied to the light guide element by means of an injection molding process or the light guide element is applied to the functional body by means of injection molding process. Consequently, the injection molding process can be performed in both directions: Each or one of the elements, namely the light guide element or the functional body, can comprise a silicone material, which can be injection molded, and the remaining element comprises a material, to which the silicone can be adhesively molded via the injection molding process.

Another preferred embodiment of the present invention provides a light guide element which comprises a number of light guiding fingers, which are configured such that a light semi-conductor light source can be arranged at the end face of each of the light guiding fingers, wherein the functional body forms a planar element. This arrangement of the light guide element and the functional body together with the semi-conductor light sources is especially suited for forming a low beam unit or a high beam unit for a headlamp of a vehicle. In particular, in case the light guide element being made of silicone and being applied to a face of the functional body via injection molding, the semi-conductor light sources can be positioned very close to or be even in contact with the end faces of the light guiding fingers. As the silicone material of the light guide element is not (or nearly not) temperature-sensitive, no temperature drift arises in the optical properties of the light guide element. The functional body which is formed as a planar element is mountable in the beam unit and carries the light guide element.

According to yet another embodiment, the light guide element features a basic section facing the functional body, wherein the number of light guiding fingers extend substantially perpendicular to the basic section.

According to another embodiment of the optical system, the functional body comprises an edge that serves as a shade edge. I.e. the shade edge provided by the functional body can be used for partially shading a light distribution provided by another part of the optical system. E.g. the shade edge can be used for generating a cut-off line in a light distribution of a low beam module of the optical system.

In particular, a part of the silicone material forming the light guide element may enclose the shade edge, wherein a respective enclosing structure of the light guide element is made by the injection molding process of the light guide element. This enclosing structure has the advantage that the injection molding process can be performed with higher quality and the molded part, namely the light guide element, is improved in its defined shape in particular with regard to the transition to the shade edge.

The invention is also directed to an optical system with a functional body which may be injection molded to the light guide element. Therein, the surface of the light guide element can be activated beforehand, so that the bonding joint is formed not before the injection-molding of the functional body and the adhesive injection molding of the functional body to the light guide element. This method thus forms a combination of a bonding method for the material connection with a simultaneous adhesive injection molding of one of the partners of the compound.

The invention is also directed to a method for providing an optical system comprising a light guide element with a joint connected functional body being materially connected to the light guide element and according to the invention, the method comprises the steps of arranging the adhesive injection molding of the functional body to the light guide element and materially connecting the functional body with the light guide element by means of a bonding joining process. Further features and respective advantages of the optical systems are also applicable to the method for providing an optical system. For example, a bonding surface, which gets in contact with the functional body, can be activated in advance of the bonding step. The activation of the bonding surface can comprise a surface activation, e.g. by means of a plasma activation or by applying a so-called corona-treatment. Only due to the activation the molecular bonds between the two joining partners can be produced which is the basis of the bonding process.

PREFERRED EMBODIMENT OF THE INVENTION

Additional details improving the invention are described as follows in connection with the description of preferred embodiments of the invention by means of the following figures. The figures show:

Fig. 1 a first embodiment of an optical system with a light guide element and with a functional body being materially connected to the light guide element, wherein the functional body forms an enclosing element;

Fig. 2 an optical system with a light guide element and with a functional body,

wherein the functional body forms a light incoupling body;

Fig. 3 a further variant of an optical system compared to the embodiment in Fig. 2;

Fig. 4 another variant of the optical system basing on the embodiment in Fig. 2;

Fig. 5 an optical system with an alternative formed light guide element and with a functional body, which forms a beam forming body;

Fig. 6 the embodiment according to Fig. 5, wherein the functional body is made of a silicone material and is arranged adjacent to a bonding surface of the light guide element;

Fig. 7 an embodiment of the optical system with a light guide element and a functional body, wherein the light guide element comprises a planar extension having a number of light guiding fingers, wherein the functional body is a light outcoupling body;

Fig. 8 a side view of the embodiment of the optical system according to Fig. 7;

Fig. 9 a more detailed embodiment of the optical system as a variant of the optical system in Fig. 7 in a first view;

Fig. 10 the optical system according to Fig. 9 in a second view with a deviating shape of the injection molded light guide element and

Fig. 11 a light module with a low beam unit and a high beam unit.

Fig. 1 shows an embodiment of an optical system 1 having a light guide element 10 and a functional body 11. The functional body 11 is materially connected to the light guide element 10, and the light guide element 10 comprises a bonding surface 12, to

which the functional body 11 with a corresponding complementary shaped geometry is joined by means of a bonding process. The embodiment of the optical system 1 shows the light guide element 10 with the functional body 11, wherein the functional body 11 forms an enclosing element 14 which encloses the light guide element 10 in a U-shape. For example, the light guide element 10 can comprise a prism structure at the bottom, so that light can be coupled out via an outcoupling surface across the main extension direction 13 of the light guide element 10. Therein, the outcoupling surface 25 is arranged opposite to the prism structure 24 at the light guide element 10, and the outcoupling surface 25 is arranged in the open side of the U-shaped functional body 11.

Fig. 2 shows an embodiment of the light guide element 10, which extends in a main extension direction 13. At the end face of the light guide element 10, a bonding surface 12 is arranged. A functional body 11 is bonded to the bonding surface 12. The functional body 11 forms a light incoupling body 15, by means of which light can be coupled into the light guide element 10. Herein, the bonding surface 12 and thus the bonding joint between the light guide element 10 and the functional body 11 are arranged in the main beam path of the optical system, wherein the bonding joint between the light guide element 10 and the functional body 11 is – from an optical point of view – formed such that the optical function of the optical system 1 is not affected.

Fig. 3 shows an embodiment of an optical system 1 which is a modification of the optical system 1 according to fig. 2. The functional body 11 is a light incoupling body 15 which is designed to be widened to one side and which is arranged via the bonding surface 12 to the light guide element 10 by means of a bonding joint. According to this embodiment, the light incoupling body 15 is arranged at a end face of the light guide element 10 in direction of the main extension direction 13.

Fig. 4 shows another variant of an embodiment of the light incoupling body 15 which laterally encloses the light guide element 10. The bonding surface 12 is consequently formed in circumferential direction and on the end face of the light guide element 10, and the light incoupling body 15 is arranged at the end of the main extension direction

13 of the light guide element 10. A bondable coating 17 is formed between the light guide element 10 and the functional body 11, for example, when either the light guide element 10 and/or the functional body 11 is made of a synthetic material. The bondable coating 17 is applied to the body made of synthetic or plastic material in advance, such that the body made of synthetic or plastic material becomes bondable to e.g. silicon. As an example, the light guide element 10 may be made of a synthetic material and the functional body 11 for forming the light incoupling body 15 may be made of silicone material.

Fig. 5 shows another embodiment of an optical system 1 with a light guide element 10, and light can be coupled into the light guide element 10, for example via the incoupling surface 26, e.g. in case that semi-conductor light sources are arranged at the incoupling surface 26. The light can be coupled out of the light guide element 10 via the bonding surface 12, wherein a functional body 11 in form of a beam forming body 22 is arranged at the bonding surface 12. The beam forming body 22 comprises for example a silicone material, which is made by an injection molding process. Herein, it is advantageous that the optical structure, which is as an example is step-like, can be easily produced in an injection molding process with a high accuracy. The production of the light guide element 10 having a larger volume is, for example, also carried out in an injection molding process, wherein the topographic accuracy of the bonding surface 12 does not have to meet very strict requirements. Due to the bonding joint with the soft silicone material of the beam forming body 22, topographic abrasions or deviations are compensated for, and the very precise optical structure 16 of the functional body 11 enables a high quality of the beam shaping of the light.

Fig. 6 shows a variant of a production process for arranging the functional body 11 to the light guide element 10, wherein the functional body 11 forms a light outcoupling body 21. Due to the flexible behavior of the silicone material the light outcoupling body 21 is able to adapt the curvature of the bonding surface 12. The soft silicone material of the light outcoupling body 21 consequently can be produced in an easy manner in a plane form and subsequently the light outcoupling body 21 can be bended and put to the light guide element 10 by means of a bonding method.

Fig. 7 shows another embodiment of an optical system 1 with a light guide element 10 having a functional body 11. The light guide element 10 comprises a number of light guiding fingers 18, wherein semi-conductor light sources can be arranged at the end surfaces of the light guiding fingers 18. The light guiding fingers 18 extend nearly parallel to each other in the main extension direction 13 of the light guide element 10. At the surface of the light guide 10 opposite to the light guiding fingers 18, which surface forms a bonding surface 12, a functional body 11 in the form of a light outcoupling body 21 is provided. The joint between the light guide element 10 and the light outcoupling body 21 comprises a bonding joint according to the invention. The light is coupled out of the light guide element 10 via the light outcoupling surface 19 forming a free surface at the light outcoupling body 21. The light outcoupling surface 19 is arranged opposite to the bonding surface 12 to which the light outcoupling body 21 is bonded.

Fig. 8 shows a front view of the optical system 1 according to fig. 7 viewing from the light outcoupling surface 19 of the functional body 11 forming the light outcoupling body 21. In dashed lines, the light guiding fingers 18 are indicated, which are arranged at the light guide element 10, wherein the light guide element 10 is arranged behind the shown light outcoupling body 21. The top edge of the light outcoupling body 21 forms a shade edge 20 which for example forms the contour of a cut-off line of a headlight. For example, the shown optical system 1 can form a high beam unit of a headlight, which is arranged in front of and below a low beam unit within the headlight housing, as described in connection with fig. 11. The shade edge 20 is used for forming the low beam light distribution with the cut-off line. I.e., a double function can be assigned to light outcoupling body 21: first, it receives the light guide element 10 made of silicone material, wherein for example the light outcoupling body 21 is made of synthetic or plastic material or a glass material. Second, the light outcoupling body 21 is used for forming the cut-off line for which the shade edge 20, for example, comprises a reflex coating and is formed on top of the functional body 11.

Fig. 9 shows the embodiment of the optical system 1 similar to the embodiment according to fig. 7 and fig. 8. The light guide element 10 made of a silicone material is connected to the functional body 11 made of a glass material or a synthetic material via adhesive injection molding. The light guide element 10 comprises a basic section 33 facing the functional body 11, wherein a number of light guiding fingers 18 extend substantially in normal direction of a front face of the basic section 33.

Fig. 10 shows a variant of the embodiment of an optical system 1 according to fig. 9. According to this embodiment, a light guide element 10 is arranged to the functional body 11, and the functional body 11 has a planar shape with a shade edge 20 on the upper side. The silicone material of the light guide element 10 encloses the shade edge 20 of the functional body 11, wherein the light guiding fingers 18 extending from the basic section 33 and the enclosing structure 29 form one single element produced by the injection molding. E.g., the injection molding may be performed in an adhesive molding to the surface of the functional body 11.

Semiconductor-light elements can be arranged at the end faces 27 of the light guiding fingers 18, and the light passes the functional body 11.

Fig. 11 shows a light module 100 having a low beam unit 40 and a high beam unit 50. The light module 100 can be arranged in the housing of a headlamp, and the high beam unit 50 is arranged in front of and below the low beam unit 40. When light is generated by the low beam unit 40, the cut-off line can be formed by means of the shade edge 20 of the optical system 1, wherein a cover plate 32 is arranged in front of the shade edge 20. The cover plate 32 is shown with an opening, so that the light guide element 10 can be seen behind the functional body 11 and the light guide element 10 comprising a number of light guiding fingers 18 is shown. Behind the light guiding fingers 18, semiconductor-light elements can be arranged (not shown).

The present invention is not limited to the embodiments described above, which are represented as an example only and can be modified in various ways within the scope of protection defined by the pending claims. Thus, the invention is also applicable to

different embodiments, in particular regarding the design of the light guide element 10 and the functional body 11.

List of Numerals

1	optical system
10	light guide element
11	functional body
12	bonding surface
13	main extension direction
14	enclosing element
15	light incoupling body
16	optical structure
17	bonding capable coating
18	light guiding finger
19	light outcoupling surface
20	shade edge
21	light outcoupling body
22	beam forming body
23	attachment protrusion
24	prism structure
25	outcoupling surface
26	incoupling surface
27	end face
28	planar element
29	enclosing structure
30	heat sink
31	heat sink
32	cover plate
33	basic section
40	low beam unit
50	high beam unit
100	light module

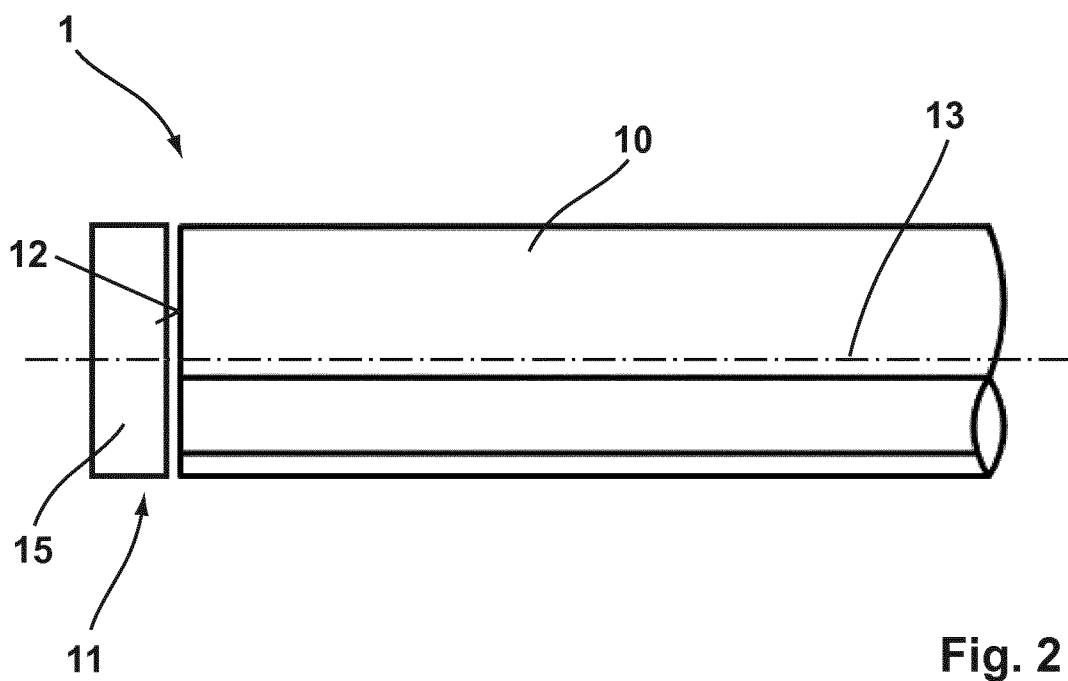
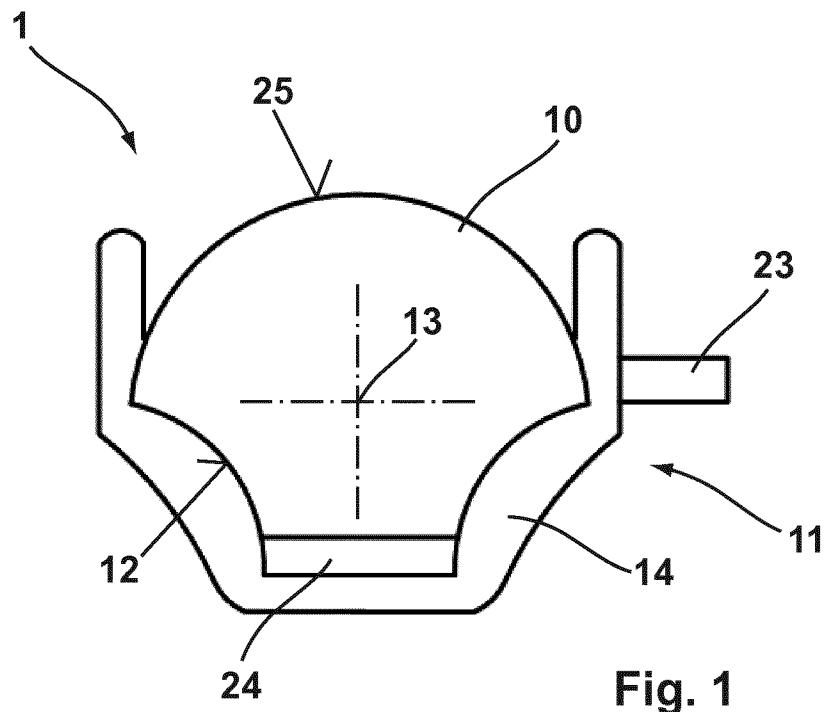
Patent Claims

1. Optical system (1) comprising a light guide element (10) and a joined functional body (11) being materially connected to the light guide element (10), **characterised in** that the joint of the functional body (11) to the light guide element (10) comprises a bonding joint.
2. Optical system (1) according to claim 1, **characterised in** that the light guide element (10) comprises a glass material or a silicone material.
3. Optical system (1) according to claim 1 or 2, **characterised in** that the functional body (11) comprises a silicone material.
4. Optical system (1) according to one of the claims 1 to 3, **characterised in** that the light guide element (10) comprises a synthetic or plastic material, whereas a bonding surface (12) of the light guide element (10) which is in contact with the functional body (11) comprises a bondable coating (17).
5. Optical system (1) according to one of the previous claims, **characterised in** that the light guide element (10) comprises a main extension direction (13), wherein the functional body (11) is formed as an enclosing element (14) in order to at least partly enclose the light guide element (10).
6. Optical system (1) according to one of the claims 1 to 4, **characterised in** that the functional body (11) forms a light incoupling body (15) or a light out-coupling body (21), which is arranged at an end face of the light guide element (10) in the main extension direction (13).

7. Optical system (1) according to one of the previous claims, **characterised in** that the functional body (11) forms a beam forming body (22) and comprises an optical structure (16).
8. Optical system (1) according to one of the previous claims, **characterised in** that the functional body (11) is applied to the light guide element (10) by means of an injection molding process or that the light guide element (10) is applied to the functional body (11) by means of an injection molding process.
9. Optical system (1) according to one of the previous claims, **characterised in** that the light guide element (10) comprises a number of light guiding fingers (18) configured for receiving light emitted from respective semi-conductor light sources arranged at the end faces (27) of the light guiding fingers (18), wherein the functional body (11) is a planar element (28).
10. Optical system (1) according to claim 9, **characterised in** that the light guide element (10) is made of silicone and is applied to the functional body (11) by injection molding, wherein the light guide element (10) comprises a basic section (33) facing the functional body (11) and wherein the light guiding fingers (18) extend out of the basic section (33).
11. Optical system (1) according to claim 9 or 10, **characterised in** that the functional body (11) comprises an edge forming a shade edge (20).
12. Optical system (1) according to claim 11, **characterised in** that a part of the silicone material forming the light guide element (10) encloses the shade edge (20), wherein a resulting enclosing structure (29) of the light guide element (10) is made by the injection molding process of the light guide element (10).
13. Optical system (1) according to one of the previous claims, **characterised in**

that the system (1) forms a high beam light unit (50) of a headlamp as a part of a light module (100).

14. Method for providing an optical system (1) comprising a light guide element (10) with a joined functional body (11) being materially connected to the light guide element (10), wherein the method comprises at least the following steps:
 - arranging or adhesive injection molding of the functional body (11) to the light guide element (10) and
 - materially connecting the functional body (11) with the light guide element (10) by means of a bonding joining process.
15. Method according to claim 13, **characterised in** that a bonding surface (12) for contacting the functional body (11) is activated in advance of the bonding process.



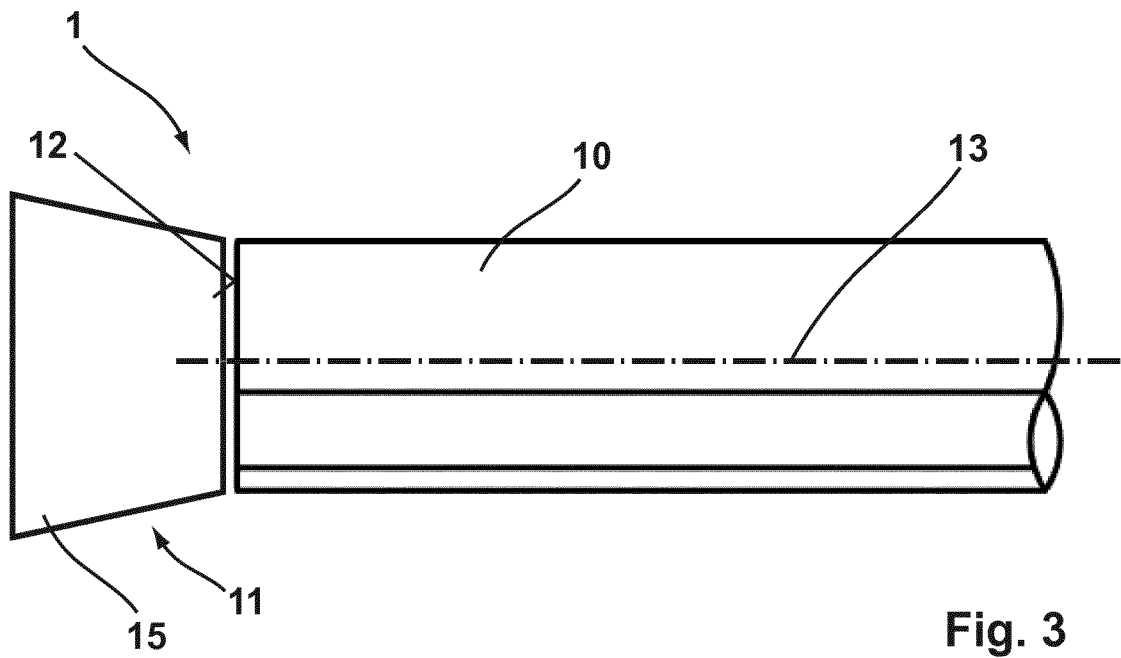


Fig. 3

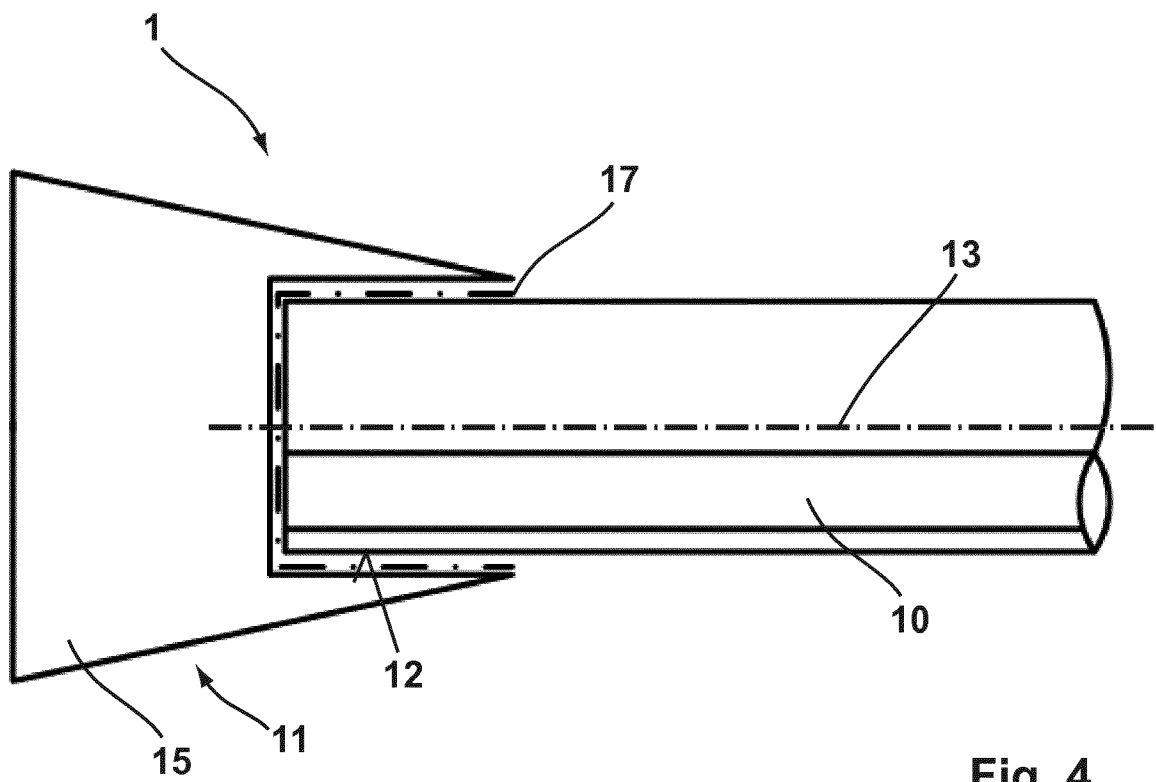


Fig. 4

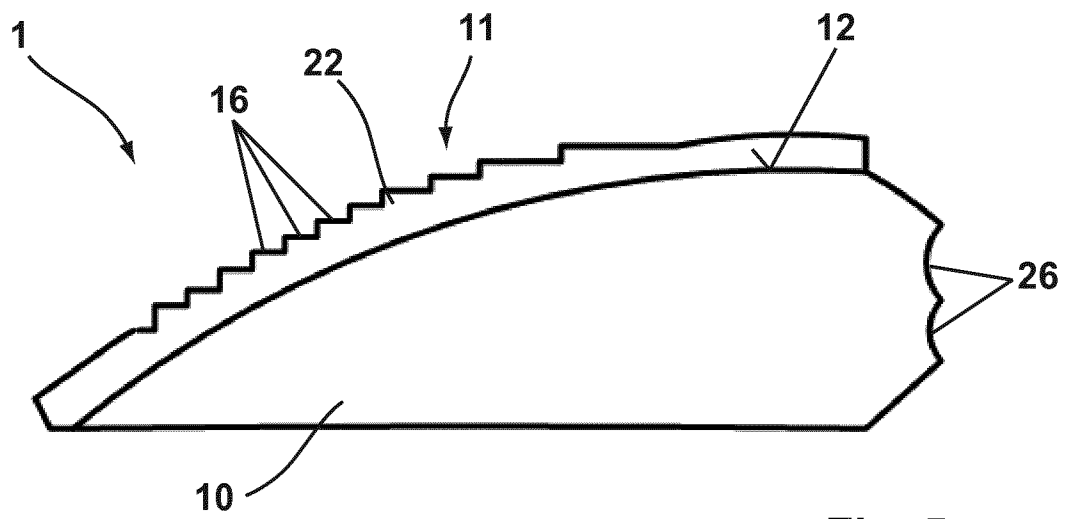


Fig. 5

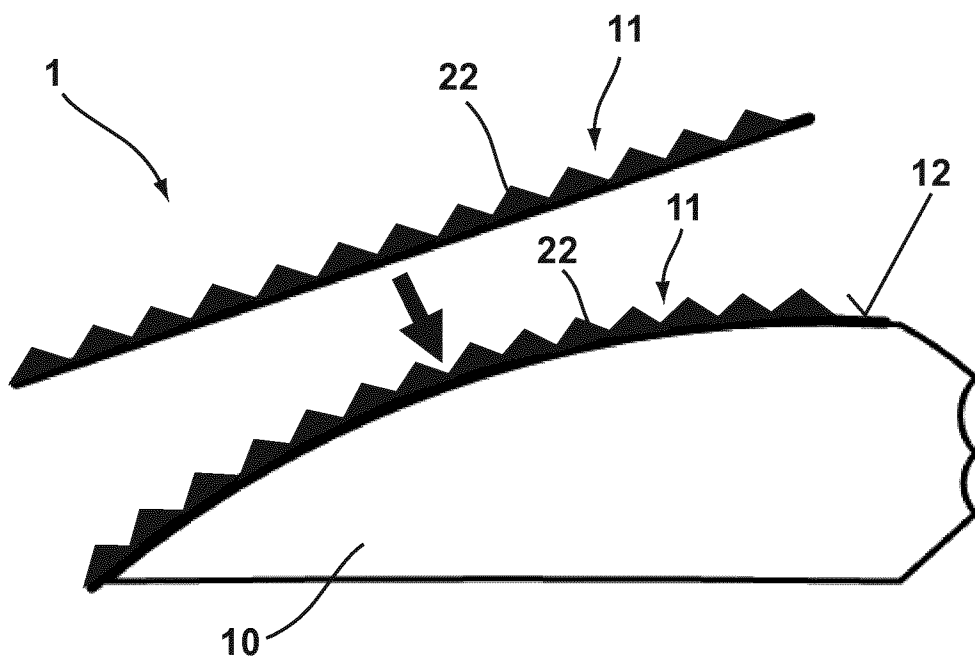
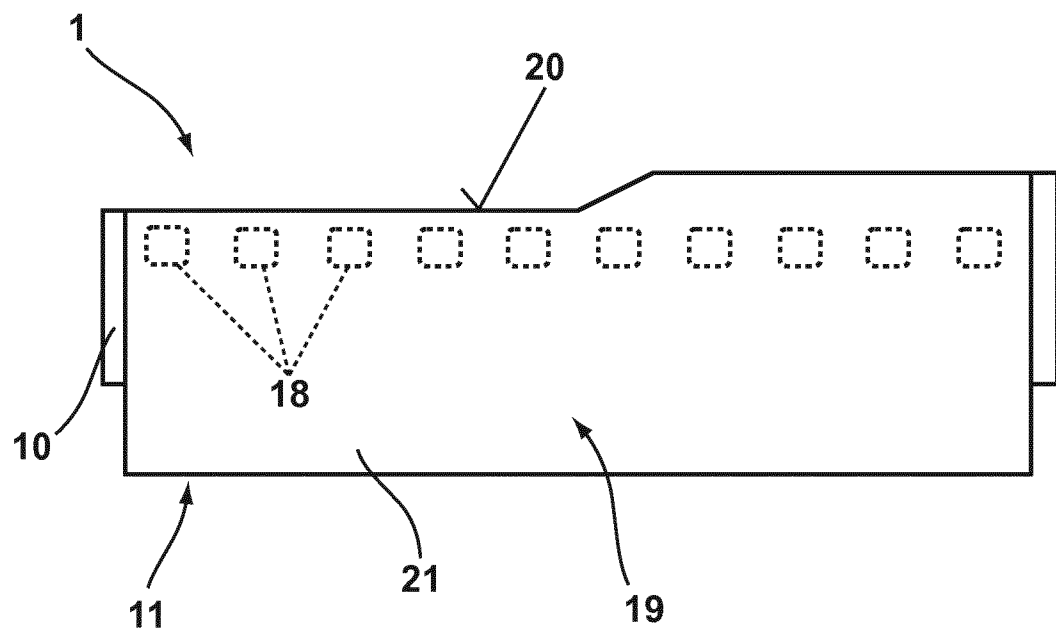
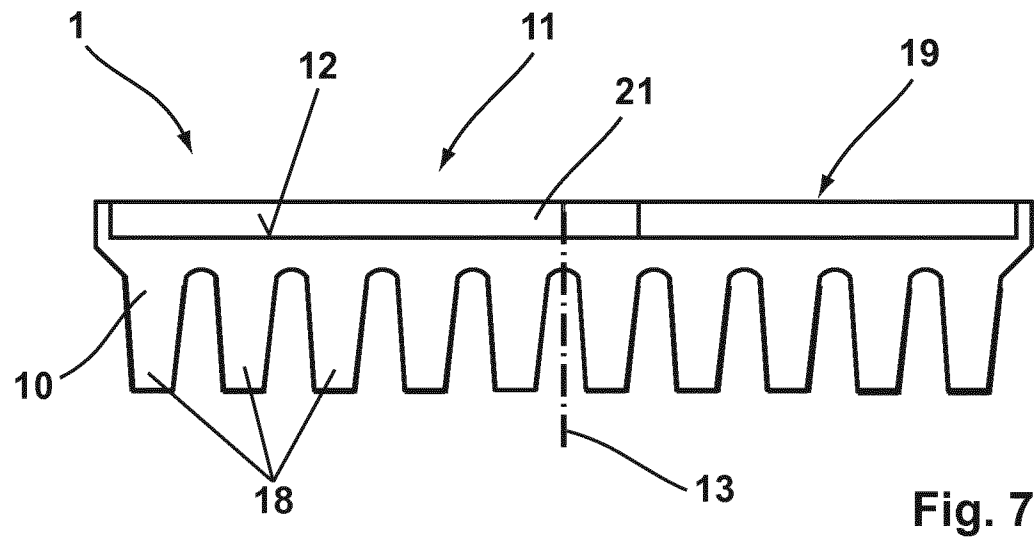
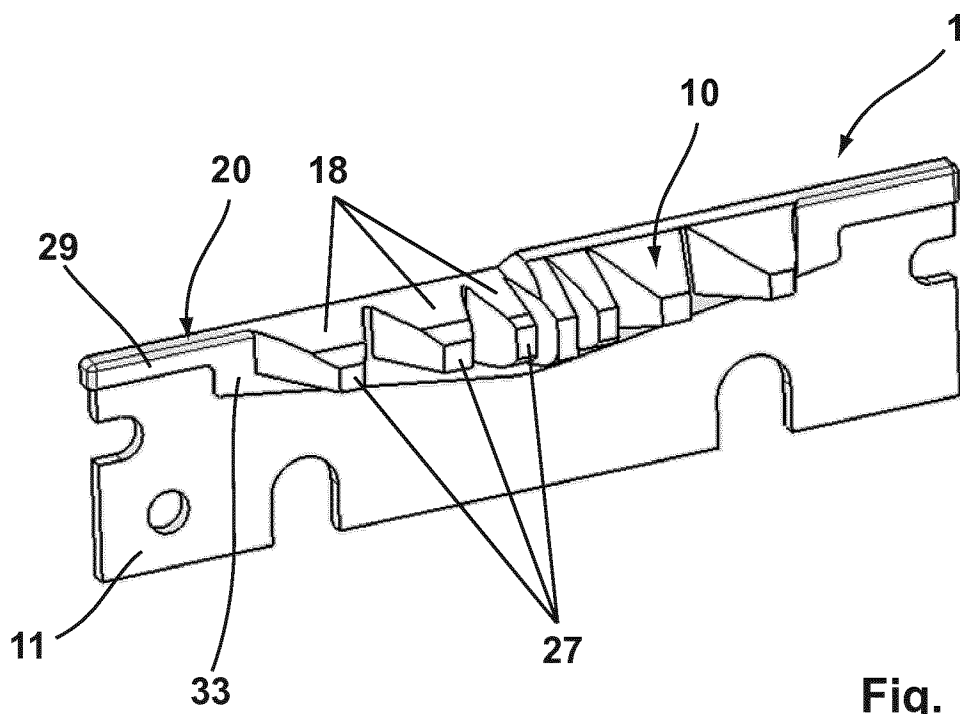
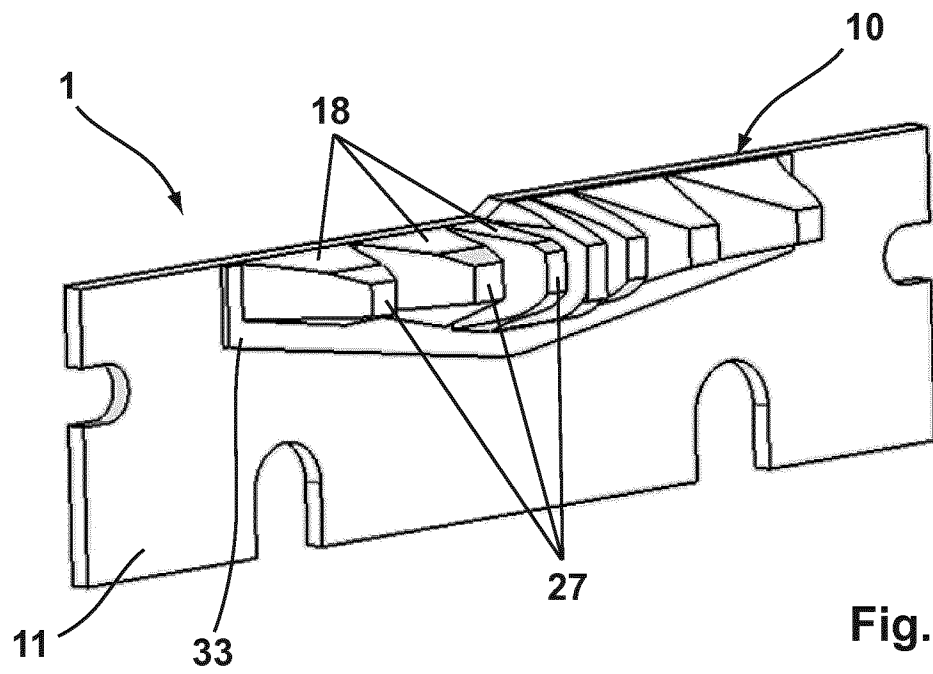


Fig. 6





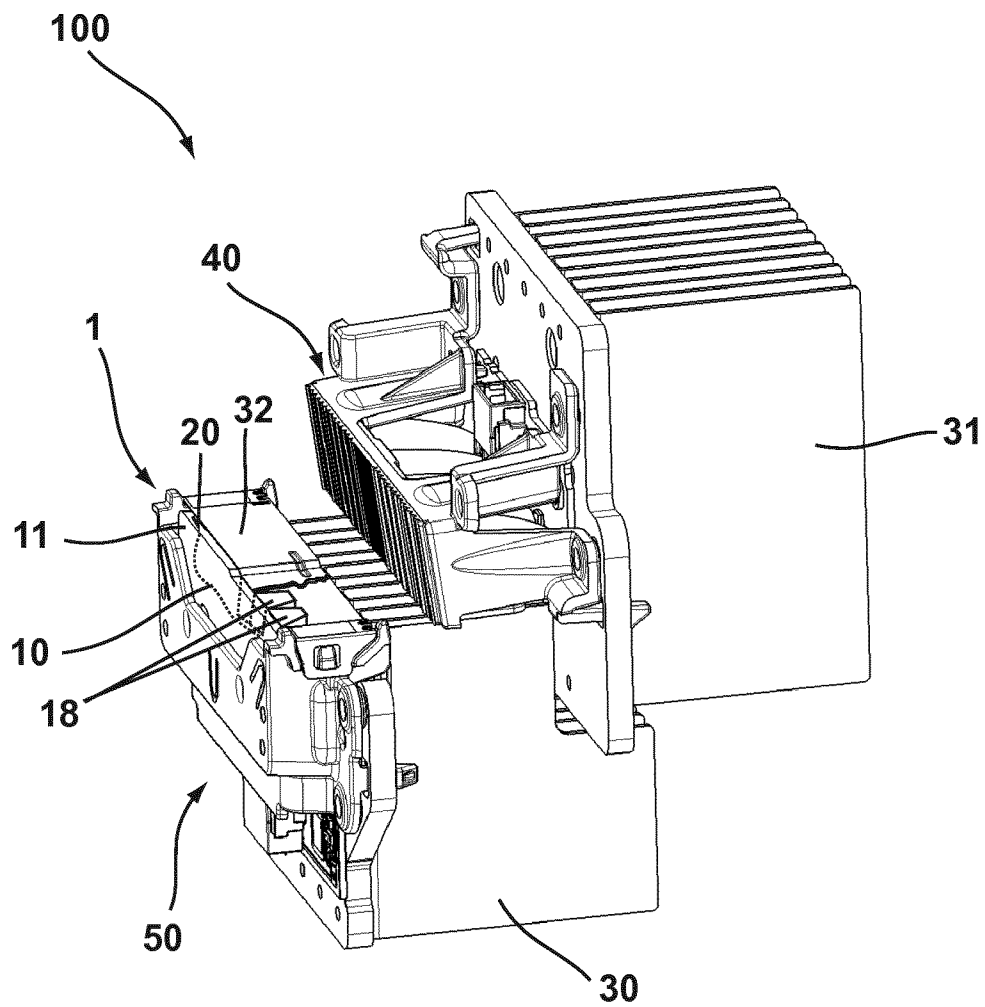


Fig. 11

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/082181

A. CLASSIFICATION OF SUBJECT MATTER
INV. F21V8/00
ADD. F21S8/10

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)
F21S G02B

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 practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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"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

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Date of the actual completion of the international search

5 April 2017

Date of mailing of the international search report

19/04/2017

Name and mailing address of the ISA/

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Kapsalis, Alexandros

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/082181

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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