

LIGHT EMITTING FILAMENT**DESCRIPTION**

5 The invention refers to a filament and to a production method of the filament. Classic filament lamps have a bad degree of efficiency, regarding the transformation of electrical power to optical power. To overcome these efficiency issues, light emitting diodes have been introduced to illuminance. To over-
10 come the efficiency issues, light emitting diodes have been arranged on a filament. Light emitting diodes produce a waste heat that has to be dissipated. The better the dissipation of the waste heat, the lower is the temperature of the light emitting diode and therefore the higher is the efficiency of
15 the light emitting diode.

In the state of the art, it is known to arrange the filament in helium gas environment to improve the heat dissipation of the light emitting diodes.

20 An assignment of the invention is to provide a light emitting filament with improved heat dissipation. Furthermore, an assignment of the invention is to provide a simple production method for producing the light emitting filament.

25 Solutions of these assignments are disclosed in the independent claims. Preferred embodiments are disclosed in the dependent claims.

30 A light emitting filament with a carrier is provided, wherein at least two optoelectronic light emitting semiconductor chips are arranged on the carrier. The carrier comprises two electrical contact elements, wherein the contact elements are fixed to the carrier. The contact elements are electrically
35 connected with the two semiconductor chips. The semiconductor chips and the carrier are at least partially covered with a light-transparent cover. The light-transparent cover is therefore directly arranged on the semiconductor chip and on

the carrier. The more surface of the semiconductor chips and the more surface of the carrier is covered by the light-transparent cover, the better is the heat dissipation.

However, depending on the used embodiment, an improved heat
5 dissipation is attained by covering at least a part of the surface of the semiconductor chip and at least a part of the carrier of the filament. The semiconductor chips may have a converter layer. Furthermore the semiconductor chips and the filament may be covered with a converter layer. In these em-
10 bodiments, the light transparent cover also covers the converter layer.

In a further embodiment, the semiconductor chips are embedded in the cover. This means that the semiconductor chips are ar-
15 ranged with bottom sides on the carrier. All other sides of the semiconductor chips, that means all other surface of the semiconductor chips, are covered by the cover. Therefore, the heat that is generated by the semiconductor chip can be dissipated directly via the cover using several faces of the
20 semiconductor chip. Therefore, the whole surface of the semiconductor chips is used for an improved heat dissipation by the light-transparent cover.

In a further embodiment, the cover comprises glass material.
25 Glass material has the advantage that it is robust, light-transparent and can easily be processed. Depending on the used embodiment, the cover can be totally made of glass material.

30 In a further embodiment, the cover has the shape of a tube. Especially if the cover is made of glass, the shape of a tube is of advantage for the production of the light emitting filament. Additionally, the tube shape improves the heat dissipation.

35 In a further embodiment, the contact elements project at opposite ends from the carrier. The cover covers the semiconductor chips and the carrier. Only the contact elements pro-

ject from the cover. This means that the whole surface of the semiconductor chips and the whole surface of the carrier is covered by the cover. This embodiment provides an improved heat dissipation, wherein the filament can easily be contact-
5 ed via the projecting electrical contacts. Furthermore, the contact elements that project from the cover increase the heat dissipation.

In a further embodiment, the cover has a thermal conductivity
10 that is higher than 0.15 W/mK. This is sufficient for a satisfying heat dissipation.

In a further embodiment, the cover has a thermal conductivity that is higher than 0.8 W/mK. This embodiment provides a high
15 heat dissipation.

In a further embodiment, the cover has a thickness above the semiconductor chips in the range between 20 mm and 1 mm. Basically, the heat dissipation increases with the thickness of
20 the cover. However the light transmission decreases with an increasing thickness of the cover. Additionally, the weight of the filament and also the production costs increase with an increasing thickness of the cover. Especially, if glass material is used for providing the cover, a thickness of
25 10 mm or less is recommended.

In a further embodiment, the cover has a diameter in a range between 20 mm and 2 mm.

30 A method of producing a light emitting filament is provided, wherein a carrier with at least two optoelectronic light emitting semiconductor chips are arranged on the carrier is provided, the carrier having two electrical contact elements, wherein the contact elements are fixed to the carrier, where-
35 in the contact elements are electrically connected with the two semiconductor chips, wherein the semiconductor chips and the carrier are at least partially covered with a light-transparent cover.

In a further embodiment, soft glass material is deposited on the semiconductor chips and on the carrier, wherein after hardening the glass material constitutes the cover.

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The above-described properties, features and advantages of this invention and the way in which they are achieved will become clearer and more clearly understood in association with the following description of the exemplary embodiments which are explained in greater detail in association with the drawings. Here in schematic illustration in each case:

- Fig. 1 shows a cross section of a filament.
- 15 Fig. 2 shows a top view of the filament of Fig. 1.
- Fig. 3 shows a cross section of a further filament.
- Fig. 4 shows a schematic cross-sectional view of the embodiment of Fig. 3.
- 20 Fig. 5 shows a cross-sectional view of a filament perpendicular to a longitudinal axis of the filament.
- 25 Fig. 6 shows a cross-sectional view of a further filament.
- Fig. 7 shows a cross-sectional view of the embodiment of Fig. 6.
- 30 Fig. 8 shows a view of an ending of the filament of Fig. 6 and 7.

Fig. 1 shows a cross section of a filament 100 for a filament lamp. The filament 100 comprises a plurality of light emitting optoelectronic semiconductor chips 110, which are located on an upper face 160 of a carrier 120. The carrier 120 may be embodied as a stiff or flexible carrier board. The carrier 120 may have the shape of a stripe. The light emitting semi-

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conductor chips 110 comprise first and second electrical contacts 111, 112 at a bottom side of the semiconductor chip 110. The carrier 120 comprises contact areas 130 that electrically connect the light emitting semiconductor chips 110 in series. Depending on the used embodiment, the light emitting semiconductor chips may also be electrically connected in parallel.

At opposite ends of the carrier 120, a first and a second electrical contact element 150, 155 are arranged. The electrical contact elements 150, 155 are electrically connected with contact areas 130. The electrical contact elements 150, 155 are provided for connecting the filament 100 with a current source. The electrical contact elements 150, 155 may be embodied as contact pins that project from the carrier 120 along the longitudinal axis of the carrier 120. The electrical contact elements 150, 155 may comprise metal or may be made of metal.

In the shown embodiment, the upper face 160 of the carrier 120 is covered by a cover 140. In the shown embodiment, side faces 113, 114, 115 and the upper faces 116 of the semiconductor chips 110 are covered by the cover 140. Depending on the used embodiment, only the upper faces 116 or only parts of the side faces 113, 114, 115 may be covered by the cover 140. The cover 140 is transparent for the light that is emitted by the optoelectronic light emitting semiconductor chips 110. The cover 140 may have a thickness 210 above the semiconductor chips 110 that is in the range between 20 mm and 2 mm.

Fig. 2 shows a top view on the filament of Fig. 1. The cover 140 totally covers the semiconductors chips 110 but only partially covers the upper face 160 of the carrier 120. Depending on the used embodiment, the whole upper face 160 of the carrier 120 might be covered by the cover 140. The electrical contact elements 150, 155 are free from the cover 140. Depending on the used embodiment, the cover 140 may also at

least partially cover an upper face of the electrical contact elements 150, 155.

Fig. 3 shows a further embodiment of the filament 100, wherein the cover 140 covers the upper face 160 of the carrier 120, side faces 170 of the carrier 120 and a bottom face 180 of the carrier 120. The cover 140 may have a thickness 210 above the semiconductor chips 110 in a range between 2 mm and 20 mm. The diameter 190 may vary depending on the used embodiment. The cover 140 may for example have a diameter 190 of about 10 mm or less.

Fig. 4 shows a schematic cross-sectional view of the embodiment of Fig. 3. The cover 140 covers the upper face 160 of the carrier 120, the bottom face 180 of the carrier 120, and the first and second side faces 170 and 175 of the carrier 120. The contact elements 150, 155 are free from the cover 140.

Fig. 5 shows a cross-sectional view perpendicular to a longitudinal axis of the carrier 120. As can be seen, the carrier 120 and the semiconductor chips 110 are embedded in the cover 140. Depending on the used embodiment, the cover 140 has a surface 200 with a circular shape. The circular shape has the advantage that the cover 140 has a large surface 200. This improves the heat dissipation that is generated by the semiconductor chip 110 by converting the electrical current to light. Light is defined as electromagnetic radiation with any wavelength visible or not.

Fig. 6 shows a cross-sectional view of a further embodiment of a light emitting filament 100 that is similar designed as the embodiments of the Fig. 3 to 5, wherein in this embodiment, the cover 140 totally covers the semiconductor chips 110 and the whole carrier 120. Also opposite endings of the carrier 120 are embedded in the cover 140. Only endings 220, 225 of the first and the second contact element 150, 155 project from the cover 140. The semiconductor chips 110 have a

conversion layer 250. The conversion layer is capable of converting a wavelength of light emitted from the light emitting semiconductor chips 110 to light with a different wavelength. Therefore, for instance white light can be achieved. The conversion layer 250 can also be embodied as one complete layer that covers in one piece all the semiconductor chips 110 and the upper face 160 of the carrier 120. The cover 140 is arranged on the conversion layer if there is any. The cover 140 also assists to dissipate the heat that is generated in the conversion layer.

Fig. 7 shows a cross-sectional view of the embodiment of Fig. 6.

Fig. 8 shows a view on the ending 220 of the first electrical contact element 150 of the filament 100 of the Fig. 6 and 7 that projects from the cover 140 along a longitudinal axis of the filament 100. In the used embodiment, the cover 140 comprises a longitudinal tube shape with a circular outer face 200.

Depending on the used embodiment, the cover 140 may also have a rough surface 200. The roughness of the surface 200 of the cover increases the surface and therefore the heat transfer to the environment. The cover 140 may comprise in all embodiments glass material or may be made of glass material. The material that is used for the cover 140 may have a thermal conductivity that is higher than 0.15 W/mK or preferably higher than 0.8 W/mK. Any kind of glass material can be used for providing the cover 140. For example fused silica or lithium-aluminosilicate glass-ceramic may be used.

Using glass as cover material simplifies the production of the light emitting filament. A simple method for producing a light emitting filament comprises the features: providing a carrier with at least two optoelectronic light emitting semiconductor chips that are arranged on the carrier. The carrier has two electrical contact elements for example at opposite

ends of the carrier. The contact elements are fixed to the carrier and are also electrically connected with the semiconductor chips. The cover is formed on the semiconductor chips and on the carrier in that way that the semiconductor chips and the carrier are at least partially covered by the light-transparent cover.

If the cover is made of glass, the glass is heated up to a softened state. The softened glass is deposited on the semiconductor chips 110 and on the carrier 120. Depending on the used method, also castings can be used for forming the shape of the cover 140. At least the first and second contact element 150, 155 project from the cover 140.

Depending on the used embodiments, the semiconductor chips 110 may have a conversion layer. The conversion layer is capable of converting a wavelength of light emitted from the light emitting semiconductor chips 110 to light of another wavelength. The conversion layer can also cover the carrier 120. Therefore, for instance white light can be achieved. The cover 140 is arranged on the conversion layer if there is any. The cover 140 also assists to dissipate the heat that is generated in the conversion layer.

The contact elements 150, 155 are provided for an electrical connection to an external current-source. The connection to the external source can be established via a spot-welding, a soldering or a gluing process. Additionally, in some embodiments only a mechanical contact may be sufficient for the electrical connection to the external voltage- or current-source.

The carrier 120 is shown as a small longitudinal stripe for example. Depending on the used embodiment, the carrier may also have other shapes. Furthermore, the carrier 120 may have a banded section or a winding section. The semiconductor chips 110 may be fixed by a glue layer on the surface 160 of the carrier 120.

The invention has been illustrated and described in detail with the aid of the preferred exemplary embodiments. Nevertheless, the invention is not restricted to the examples disclosed. Rather, other variants may be derived therefrom by a person skilled in the art without departing from the protective scope of the invention.

REFERENCE SYMBOLS

	100	filament
	110	semiconductor chip
5	111	first electrical contact
	112	second electrical contact
	113	side face of the semiconductor chip
	114	side face of the semiconductor chip
	115	side face of the semiconductor chip
10	116	upper face of the semiconductor chip
	120	carrier
	130	contact areas
	140	cover
	150	first electrical contact element
15	155	second electrical contact element
	160	upper face of the carrier
	170	first side face of the carrier
	175	second side face of the carrier
	180	bottom face of the carrier
20	190	diameter
	200	outer face of the cover
	210	thickness
	220	ending of the first electrical contact element
	225	ending of the second electrical contact element
25	250	conversion layer

CLAIMS

1. Light emitting filament (100) with a carrier (120), with
at least two optoelectronic light emitting semiconductor
5 chips (110), wherein the semiconductor chips (110) are
arranged on the carrier (120), with two electrical con-
tact elements (150, 155), wherein the contact elements
(150, 155) are fixed to the carrier (120), wherein the
contact elements (150, 155) are electrically connected
10 with the two semiconductor chips (110), wherein the semi-
conductor chips (110) and the carrier (120) are at least
partially covered with a light transparent cover (140).
2. The light emitting filament (100) of claim 1, wherein the
15 semiconductor chips (110) are embedded in the cover
(140), wherein bottom face of the semiconductor chips
(110) are arranged on the carrier (120), wherein side
faces (112, 114, 115) and upper faces (116) of the semi-
conductor chips (110) are covered by the cover (140).
- 20 3. The light emitting filament (100) according to the pre-
ceding claims, wherein the cover (140) comprises glass
material.
- 25 4. The light emitting filament (100) of claim 3, wherein the
cover (140) is made of glass.
5. The light emitting filament (100) of any one of the pre-
ceding claims, wherein the cover (140) has the shape of a
30 longitudinal tube with a circular surface in a plane per-
pendicular to the longitudinal tube.
6. The light emitting filament (100) of any one of the pre-
ceding claims, wherein the contact elements (150, 155)
35 project at opposite ends from the carrier (120), wherein
the cover (140) covers the semiconductor chips (110) and
the carrier (120), wherein endings (220, 225) of the con-
tact elements (150, 155) project from the cover (140).

7. The light emitting filament (100) of any one of the preceding claims, wherein the cover (140) has a thermal conductivity that is higher than 0.15 W/mK.

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8. The light emitting filament (100) of any one of the preceding claims, wherein the cover (140) has a thermal conductivity higher than 0.8 W/mK.

10 9. The light emitting filament (100) according to any one of the preceding claims, wherein the cover (140) has a thickness (210) above the semiconductor chip (110) in a range between 20 mm and 1 mm.

15 10. The light emitting filament (100) according to any one of the preceding claims, wherein the cover (140) has a diameter (190) in a range between 20 mm and 2 mm.

11. A method of producing a light emitting filament (100),
20 wherein a carrier (120) with at least two optoelectronic light emitting semiconductor chips (110) are arranged on the carrier (120) is provided, the carrier (120) having two electrical contact elements (150, 155), wherein the contact elements (150, 155) are fixed to the carrier
25 (120), wherein the contact elements (150, 155) are electrically connected with the two semiconductor chips (110), wherein the semiconductor chips (110) and the carrier (120) are at least partially covered with a light-transparent cover (140).

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12. The method of claim 11, wherein the semiconductor chips (110) are embedded in the cover (140), wherein bottom face of the semiconductor chips (110) are arranged on the carrier (120), wherein side faces (112, 114, 115) and upper faces (116) of the semiconductor chips (110) are covered by the cover (140).

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13.The method according to any one of the claims 11 or 12,
wherein is soft glass material is deposited on the semi-
conductor chips (110) and on the carrier (120), wherein
after hardening the glass material constitutes the cover.

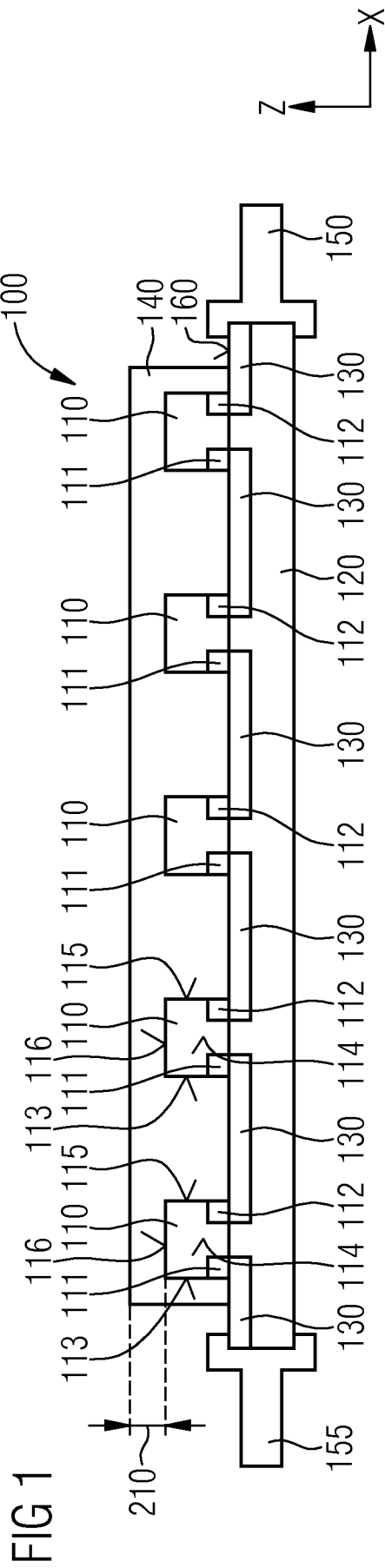
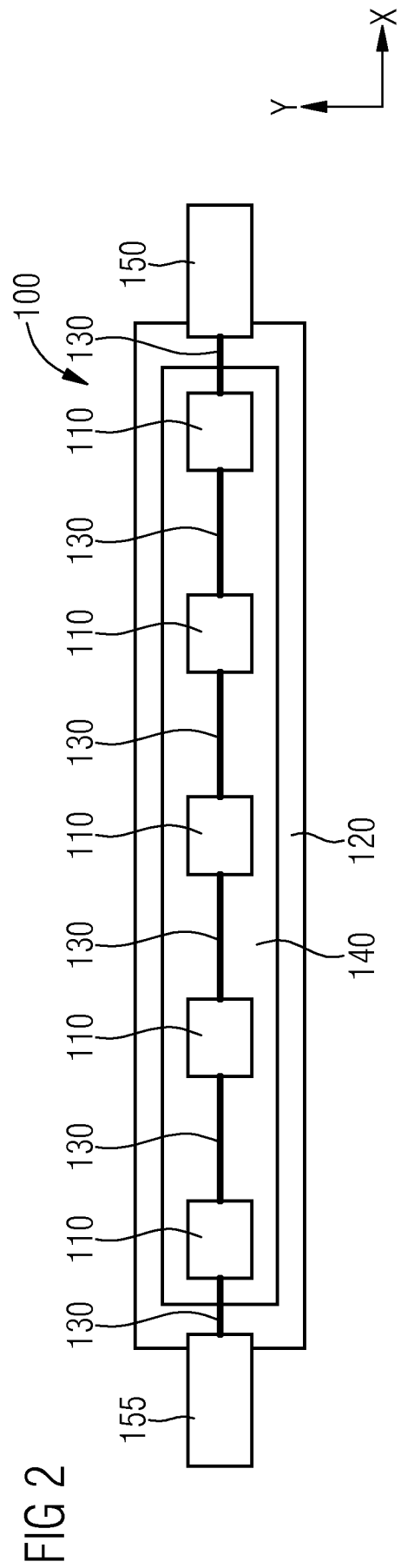
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14.The method according to one of the claims 11 to 13,
wherein the cover (140) is formed in that way on the sem-
iconductor chips (110) and on the carrier (120), that the
contact elements (150, 155) project from the cover (140).

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15.The method of any one of the claims 11 to 14, wherein the
used cover (140) has a thermal conductivity that is high-
er than 0.8 W/mK.

15 16.The method of any one of the claims 11 to 15, wherein the
cover (140) is formed with a thickness (210) above the
semiconductor chip (110) in a range of 10 mm or less.



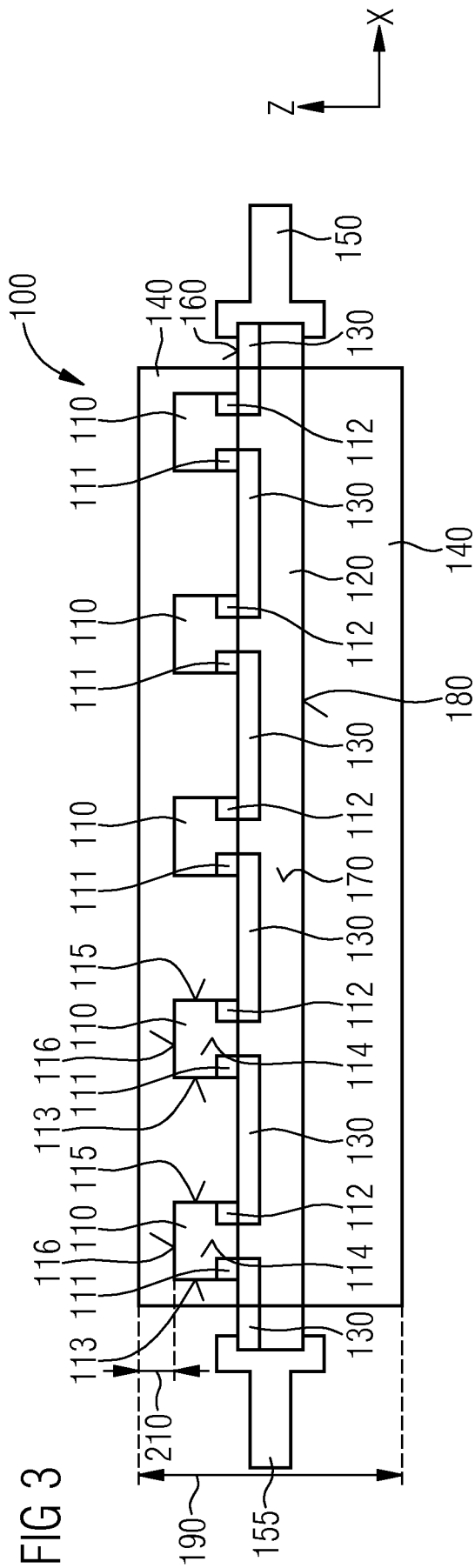
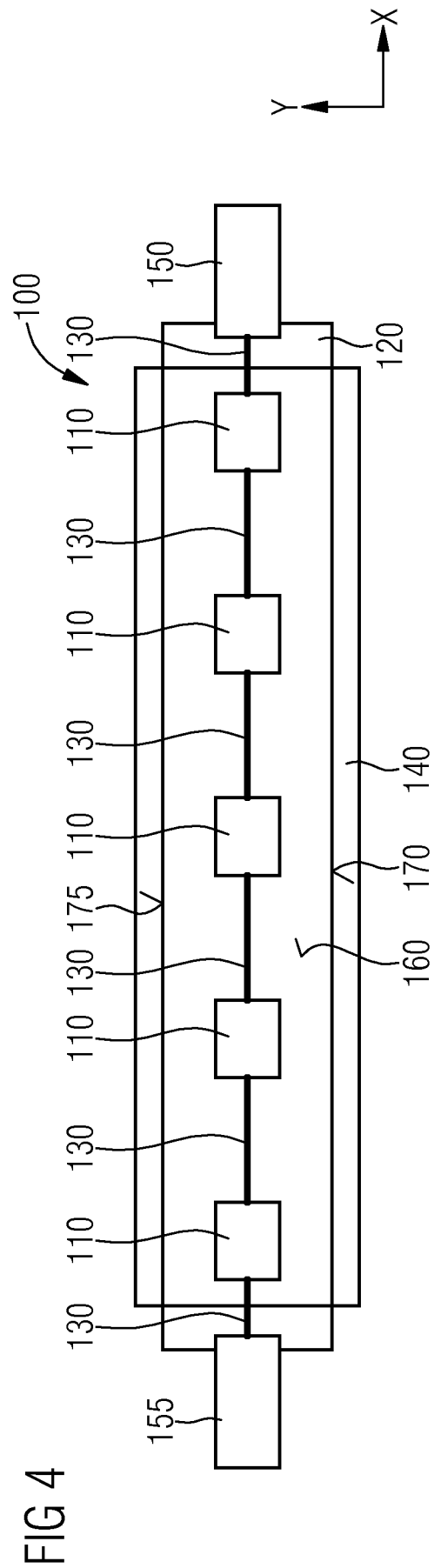


FIG 5

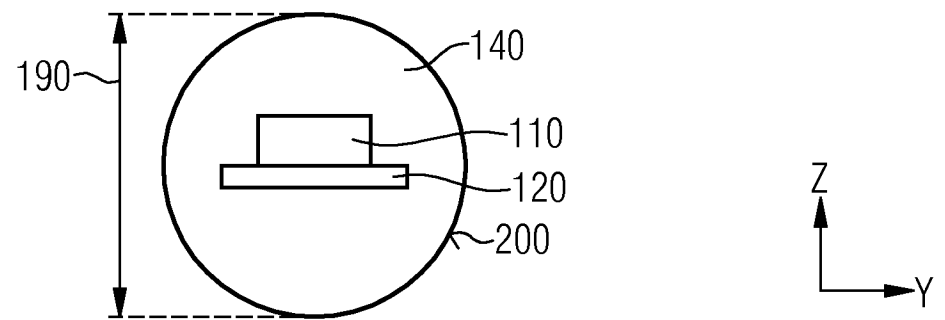


FIG 6

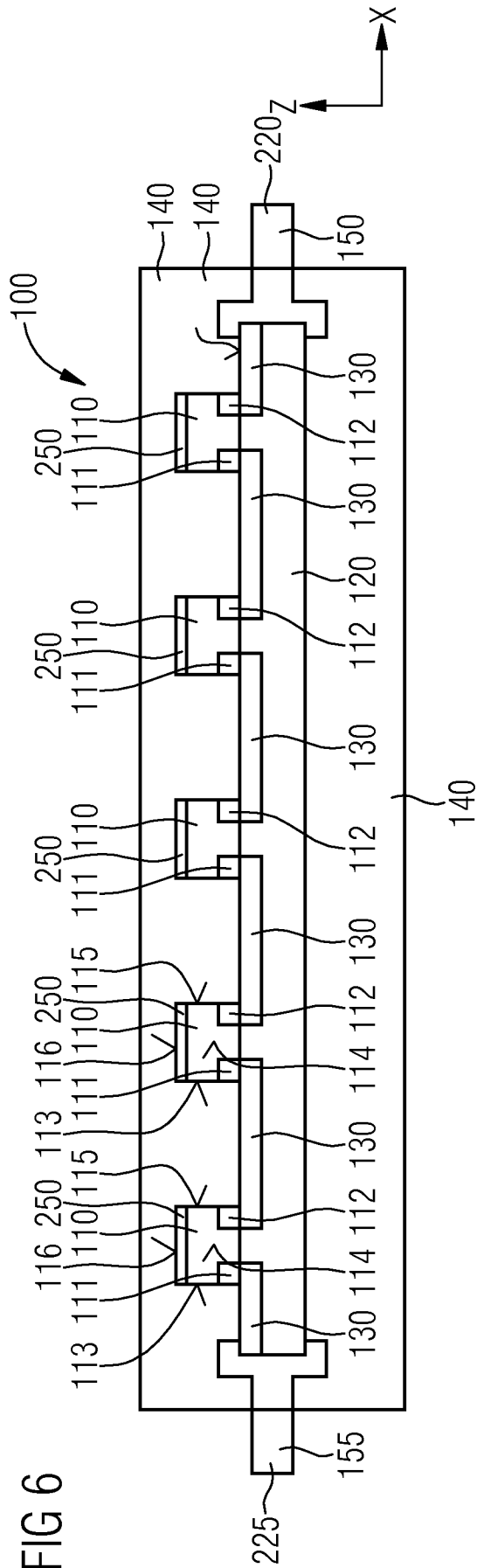


FIG 7

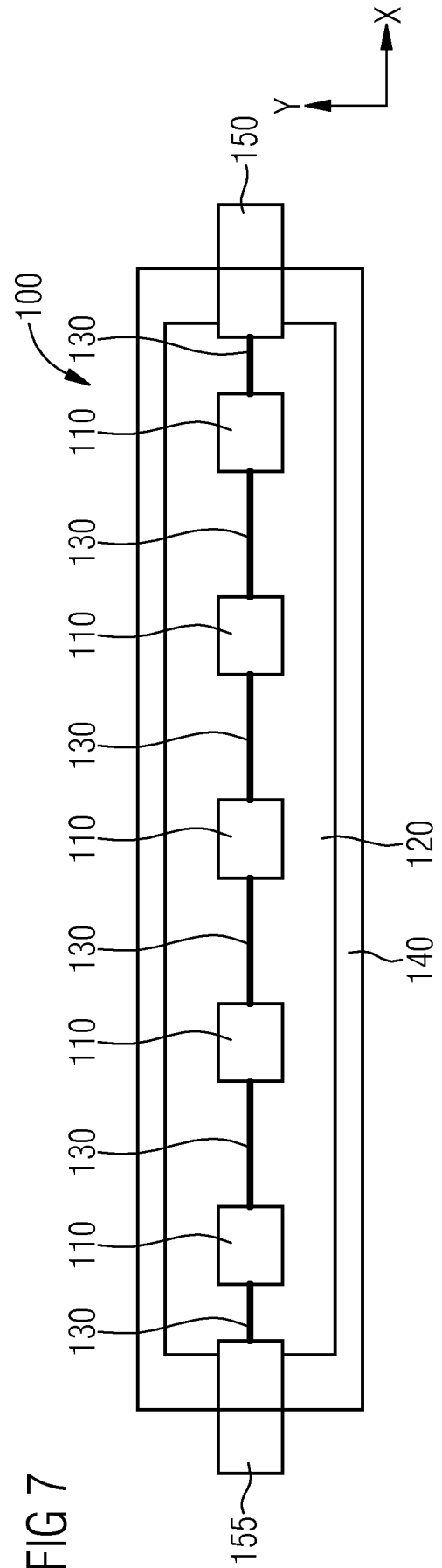
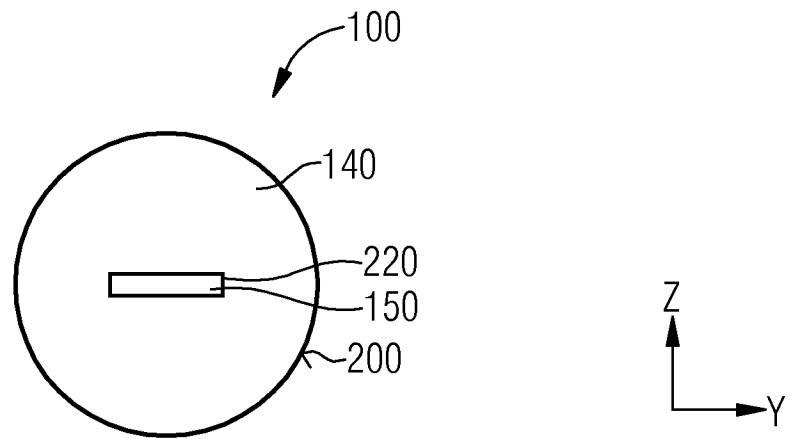


FIG 8



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/081670

A. CLASSIFICATION OF SUBJECT MATTER
INV. F21K9/00
ADD. H01L25/075 H01L33/56

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)
H01L F21K

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

C. 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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Further documents are listed in the continuation of Box C.



See patent family annex.

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Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

van der Linden, J

INTERNATIONAL SEARCH REPORT

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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