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(54) **A COVER MEMBER FOR A DROPLET FORMING UNIT**

(57) A print head assembly (1) comprising:
- a support body (50) from which at least one droplet forming unit (40) at least partially protrudes in a first direction (D), and
- a cover member (10) surrounding the at least one droplet forming unit (40), characterized in that the cover member (10) comprises:
- a circumferential wall (31) mounted on the support body (50), extending in the first direction (D), and surrounding

the at least one droplet forming unit; and
- a sheet (20) attached to the circumferential wall (31) and comprising an opening (22) through which the at least one droplet forming unit is accessible in the first direction. Providing the sheet and the circumferential wall as separate components allows for a wider selection of materials for each component, resulting in a cover member with a well-defined, flat end face.

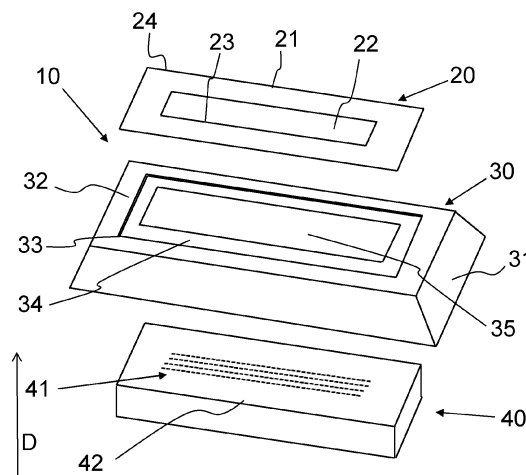


Fig. 1

Description

FIELD OF THE INVENTION

[0001] The invention relates to a print head assembly comprising a cover member for a droplet forming unit, such a cover member, and a method for assembling such a print head assembly.

BACKGROUND OF THE INVENTION

[0002] Protective cover members for droplet forming units in a print head assembly are known, for example from NL 2022897. The print head assembly comprises a support body from which at least one droplet forming unit at least partially protrudes in a first direction. The first direction generally being in the droplet jetting direction of the droplet forming unit during use. The print head assembly further comprises a cover member which surrounds the at least one droplet forming unit to protect it from coming into contact with a print medium, which is moved with respect to the print head assembly while forming the image. The cover member may further prevent ink contamination by at least partially providing a seal around the droplet forming unit. The known cover members are generally formed of single material, for example by injection molding or stamping.

SUMMARY OF THE INVENTION

[0003] It is an object of the invention to provide an improved cover member for use in a print head assembly, specifically a cover member with improved flatness and/or compatibility with the support body.

[0004] In accordance with the present invention, a print head assembly according to claim 1, a cover member according to claim 14, and a method according to claim 15 are provided.

[0005] In order to achieve the above described object, the cover member comprises:

- a circumferential wall mounted on the support body, extending in the first direction, and surrounding the at least one droplet forming unit; and
- a sheet attached to the circumferential wall and comprising an opening through which the at least one droplet forming unit is accessible in the first direction.

The circumferential wall and the sheet are provided as separate components, allowing each to be formed from its specific material(s) and/or by its specific manufacturing method, substantially independent of one another. The material of the circumferential wall may be selected, for example, to match the material of the support body in terms of thermal expansion coefficients, adhesion, or other relevant properties. The circumferential wall may be manufactured by a first manufacturing method, such as injection molding or stamping. The sheet is manufac-

ured independently from the circumferential wall allowing for a different manufacturing process, for example one which allows for the formation of a sheet of high flatness, such as rolling or pressing. Since the sheet forms the majority of the surface of the cover member facing in the first direction, a very flat and well-defined face of the cover member and droplet forming unit is achieved. This flat end face allows for an accurate setting of the so-called print gap, the distance between the print medium and the droplet forming unit. The print gap can in this manner be relatively small, which is beneficial for positioning the ink droplets, and in turn for the image quality. Thereby the object of the present invention has been achieved.

[0006] More specific optional features of the invention are indicated in the dependent claims.

[0007] In an embodiment, the circumferential wall is provided with a support for attaching the sheet. The support provides a convenient attachment point for securing the sheet to the circumferential wall. Preferably, the support is a ridge provided circumferentially along the circumferential wall, for example on the inner side or face of the circumferential wall. The support ridge allows the sheet to be supported at several points along its circumference, ensuring the flatness of the sheet is maintained in the mounted state. It is further preferred that the support extends over the full circumference of the circumferential wall. This improves support of the sheet and further allows the interface between the sheet and the support to be sealed, preventing any fluid from creeping underneath the sheet. This improves device lifetime and reduces contamination. Very preferably, the sheet is attached to the support by means of an adhesive. The adhesive provides easy attachment means, while also forming a fluidtight seal between the sheet and the support.

[0008] In an embodiment, the sheet is a flat sheet. The sheet has a high degree of flatness, both in its surface properties (e.g. roughness) as well as in its shape (e.g. planar or two-dimensional). The sheet forms (the majority of) the end face of the print head assembly facing the print medium. A very flat end face allows for a narrow spacing (a so-called print gap) between the print medium and the nozzles of the droplet forming unit. This is beneficial for the image quality of the printed image.

[0009] In an embodiment, the opening is a central opening remote from all outer edges of the sheet. The sheet comprises an inner edge or edges surrounding the opening, which inner edge is spaced apart from the outer edge or edges of the sheet. The outer edge is supported on the support, while the inner edge or edges are positioned inside the support, when viewed in the first direction in the mounted state. The opening in the sheet has a smaller area than an opening formed by the support. The latter opening is in turn smaller than an opening circumscribed by the circumferential wall.

[0010] In an embodiment, the sheet is formed from a first material different from a second material, the circumferential wall being formed of the second material. Since

the sheet and the circumferential wall are provided as separate components, these may be formed of different materials and by different manufacturing methods as well. This allows for a wider selection of materials for each respective component, as compared to an integral cover member as known in the state of the art. For example, the material and manufacturing method for sheet may be selected to optimize its flatness, and/or wetting properties with respect to the type of fluid applied. The material for the circumferential wall may be chosen based on different criteria, such as a match between the circumferential wall and the support body upon which it is mounted. Since the print head assembly heats up during use, the cover member is formed and/or mounted to compensate for thermal expansion. The structure and attachment of the cover member are such that its integrity is maintained during heating. Preferably, the second material has a thermal expansion coefficient (CTE) resembling that of the support body. A close match in CTE ensures the cover member remains properly secured to the support body, reducing the chance of contamination by ink creeping into the cover member. Similarly, a CTE of the sheet may be matched to that of the circumferential wall in another embodiment. Additionally, the CTE of the sheet material may resemble that of the droplet forming unit (which may be formed of silicon by MEMS manufacturing). Any strain on the droplet forming unit due a thermal expansion coefficient mismatch is also minimized or prevented in this manner, which benefits the print head assembly's print quality and/or lifetime. Alternatively, a flexible and/or deformable adhesive may be applied to attach the circumferential wall to the support body, which adhesive is arranged to compensate and/or allow for differences in thermal expansion between the wall and the support body. Likewise, such an adhesive may be applied to attach the sheet. It will further be appreciated that thermal expansion can additionally or alternatively be compensated, even when the CTEs of the different materials in the support body, circumferential wall, and/or sheet are relatively far apart from one another, by a suitable arrangement of said materials with respect to one another and/or structural adjustments that allow for the release of strain due to thermal expansion. It is further preferred that the first material is a metal, preferably a transition metal, and very preferably comprises titanium (Ti). Preferably, the second material is a plastic, preferably a liquid crystal polymer (LCP) and very preferably the third material is a ceramic, preferably comprising silicon carbide (SiC).

[0011] In an embodiment, a plurality of droplet forming units are mounted spaced apart from one another on the support body, and wherein each droplet forming unit is individually surrounded by its respective cover member. The cover member is dimensioned to fit and/or cover a single droplet forming. Each single droplet forming unit may be defined by its own respective nozzle plate or main body prior to mounting on the support body. The cover members are also mounted at a distance from one an-

other.

[0012] The present invention further relates to a cover member for use in a print head assembly according to the present invention, comprising:

- an endless, circumferential wall extending in a first direction; and
- a sheet attached to the circumferential wall, the sheet further comprising a through-hole forming an opening.

The cover member may be embodied in any of the above described forms.

[0013] The present invention further relates to a method for assembling a print head assembly, comprising the steps of:

- mounting at least one droplet forming unit on the a support body, such that the at least one droplet forming unit protrudes from the support body in a first direction;
- attaching a sheet comprising an opening to a circumferential wall to form a cover member;
- mounting the cover member, such that the cover member surrounds the at least one droplet forming unit, and that the opening is aligned with nozzles on a nozzle plate of the droplet forming unit.

[0014] In the mounted state, the droplet forming unit extends out of the top plane of the support body, like an island. The cover member is mounted over the droplet forming unit by attaching it to the support body, thereby aligning the opening in the sheet with the nozzles, such that the nozzles are free from the sheet. Prior to mounting, the sheet has been cut to size and provided with an opening in a manufacturing process separate from that of the circumferential wall. After their individual forming processes, the sheet and the circumferential wall are attached to one another to form the cover member. As explained above, this provides a large degree of freedom in material selection and manufacturing processes for each component, allowing for the creation for a relatively low-costs and highly flat cover member.

[0015] Further scope of applicability of the present invention will become apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the present invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the present invention will become apparent to those skilled in the art from this detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The present invention will become more fully understood from the detailed description given herein below and the accompanying drawings which are given by

way of illustration only, and thus are not limitative of the present invention, and wherein:

Fig. 1 is a schematic, exploded, perspective view of a droplet forming unit with a cover member according to the present invention;

Fig. 2 is a schematic, perspective view of a print head assembly comprising a plurality of the droplet forming units with cover members, as shown in Fig. 1; and

Fig. 3 is a schematic, cross-sectional view of a droplet forming unit with the cover member as mounted on the print head assembly of Fig. 2.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0017] The present invention will now be described with reference to the accompanying drawings, wherein the same reference numerals have been used to identify the same or similar elements throughout the several views.

[0018] Fig. 1 schematically illustrates an exploded, perspective view of a droplet forming unit 40 in combination with a cover member 10. The droplet forming unit 40 may be one of multiple droplet forming units 40 provided together on a common support body 50 of a print head assembly 1, as shown in Fig. 2. The droplet forming unit 40 comprises a nozzle plate 42 provided with a plurality of nozzles 41. The nozzles 41 in Fig. 1 are provided in straight rows, but may be provided in any suitable pattern, such as a staggered or zigzag pattern. Each nozzle 41 is in fluid connection to a pressure chamber, which pressure chamber is in fluid connection to a fluid reservoir. Each pressure chamber is provided with an actuator for generating a pressure pulse in the pressure chamber, which results in a droplet of fluid being jetted from the respective nozzle. Such droplet forming units are known, for example from US 10391768 B.

[0019] A cover member 10 is provided over the droplet forming unit 40 in the mounted state as shown in Fig. 2 with a cross-sectional view in Fig. 3. The cover member 10 is formed of a base 30 comprising a circumferential wall 31, which extends fully around the droplet forming unit 40 as an endless loop. The circumferential wall 31 extends in the first direction D. In the example shown, the circumferential wall 31 is slightly inclined with respect to first direction D. The first direction D is perpendicular to the nozzle plate 42. During use, the first direction D is preferably parallel to the vertical direction and extends in the direction of gravity. The outer perimeter of the circumferential wall 31 is greater than the outer perimeter formed by the side walls of the droplets forming unit 40, allowing the droplet forming unit 40 to fit and/or be received inside the circumferential wall 31. In Fig. 1 the circumferential wall 31 tapers in the first direction D to-

wards its top surface 31, wherein top is defined with respect to the first direction D. The top surface 32 of the base 30 is provided with an opening 35. The opening 35 is dimensioned to exceed the combined area of the nozzles 41, such that the nozzles 41 are exposed in the mounted state. Adjacent the opening 35 a support 34 is provided for receiving the sheet 20. The support 34 extends perpendicular to the first direction D on the inside of the circumferential wall 31, the support 34 is formed as an endless ridge, which forms the full edge of the opening 35. In Fig. 1, the support 34 is formed as a recess in the top surface 32, creating a step 33 on the top surface 32 of the base 30.

[0020] The support recess or ridge in Fig. 1 is dimensioned to fit the sheet 20. The sheet 20 is also provided with an opening 22. The opening 22 is dimensioned and positioned, such that in the mounted state the nozzles 41 are exposed. This allows the nozzles 41 to jet ink droplets in the mounted state. The opening 22 of the sheet 20 is smaller in area than the opening 35 in the base 30. The sheet 20 itself, specifically its outer circumference 24, is larger than the opening 35 in the base 30. The opening 22 in the sheet 20 is located centrally on the sheet 20, remote from the outer edges 24 of the sheet 20. This allows the sheet 20 to be supported on the support 34, while creating an opening 22 for the nozzles 41. Preferably, the edge 23 of the opening in the sheet 20 is positioned adjacent or near the outer nozzles 41 in the mounted state.

[0021] The sheet 20 is mounted on to the base 10 by means of suitable attachment means 25. Preferably, the sheet 20 is bonded onto the support 34 in a fluidtight and/or airtight manner by means of an adhesive 25. This prevents or reduces fluid accumulating inside the cover member 10 and contaminating the print medium when it is released. Other attachment means 25 may include clamps, click mechanisms, raised ridges, hooks, etc.

[0022] The sheet 20 is formed of a first material different from that of the base 30. The sheet 20 is preferably formed separately from the base 30 with a manufacturing method suitable for achieving a high degree of flatness, such as rolling or pressing. The first material may be a metal, such as titanium, platinum, silver, or any other suitable metal or alloy. Alternatively, plastics may also be applied for forming the sheet 10. The sheet 10 is further cut to size using an accurate cutter. A (laser) milling device may for example be applied to cut the inner and outer edges 23, 24 of the sheet 20. This allows for the formation of a sheet 10 with an opening 22 and a well-defined and very flat top surface 21.

[0023] The base 30 is preferably formed separately from the sheet 10. The tapered shape of the base 30 allows it to be conveniently formed by injection molding, deep drawing, vacuum drawing, stamping, though other suitable manufacturing techniques may be applied. The base 30 is formed of a different material than the sheet 20. The material of the base 30 may thus be selected in correspondence with requirements for the base 30 and/or

its preferred manufacturing process, such as a thermal expansion coefficient close to that of the support body 50. Since the manufacturing method for the base 30 may be different from that of the sheet 20, additional freedom in the material selection for both components is achieved. The material for the base 30 is preferably a plastic and/or comprises at least one polymer. It was found that a liquid crystal polymer (LCP) material for the base 30 resulted in a good match in thermal expansion coefficient a support body 50 formed of a ceramic, such as silicon carbide (SiC). Similarly, a sheet formed of titanium has a good CTE match with the silicon material used for forming the droplet forming unit. Additionally or alternatively, differences in thermal expansion between components can be compensated through a suitably thick adhesive layer bonding said components together and/or by other known method for compensating thermal expansion.

[0024] In Fig. 2, the cover member 10 is mounted on the support body 50. The base 30 of the cover member 10 may thereto be provided with one or more attachment means 38, such a clamp, hook, magnet, click mechanism, adhesive, etc. Preferably, a print head assembly 1 comprises multiple droplet forming units 40 provided spaced apart from one another on the same support body 50. The droplet forming units 40 are preferably mounted in a staggered pattern, such that neighboring droplet forming units 40 partially overlap when viewed in a direction wherein the print head assembly and the print medium move with respect to one another. The droplet forming units 40 each protrude from the support body 50 when mounted thereon. Though not show, it will be appreciated that the support body 50 is provided with a plurality of channels for distributing fluid to the different droplet forming units 40 mounted on it.

[0025] Although specific embodiments of the invention are illustrated and described herein, it will be appreciated by those of ordinary skill in the art that a variety of alternate and/or equivalent implementations exist. It should be appreciated that the exemplary embodiment or exemplary embodiments are examples only and are not intended to limit the scope, applicability, or configuration in any way. Rather, the foregoing summary and detailed description will provide those skilled in the art with a convenient road map for implementing at least one exemplary embodiment, it being understood that various changes may be made in the function and arrangement of elements described in an exemplary embodiment without departing from the scope as set forth in the appended claims and their legal equivalents. Generally, this application is intended to cover any adaptations or variations of the specific embodiments discussed herein.

[0026] It will also be appreciated that in this document the terms "comprise", "comprising", "include", "including", "contain", "containing", "have", "having", and any variations thereof, are intended to be understood in an inclusive (i.e. non-exclusive) sense, such that the process, method, device, apparatus or system described herein is not limited to those features or parts or elements

or steps recited but may include other elements, features, parts or steps not expressly listed or inherent to such process, method, article, or apparatus. Furthermore, the terms "a" and "an" used herein are intended to be understood as meaning one or more unless explicitly stated otherwise. Moreover, the terms "first", "second", "third", etc. are used merely as labels, and are not intended to impose numerical requirements on or to establish a certain ranking of importance of their objects.

[0027] The present invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the present invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

Claims

1. A print head assembly (1) comprising:

- a support body (50) from which at least one droplet forming unit (40) at least partially protrudes in a first direction (D), and
- a cover member (10) surrounding the at least one droplet forming unit (40), **characterized in that** the cover member (10) comprises:
 - a circumferential wall (31) mounted on the support body (50), extending in the first direction (D), and surrounding the at least one droplet forming unit (40); and
 - a sheet (20) attached to the circumferential wall (31) and comprising an opening (22) through which the at least one droplet forming unit (40) is accessible in the first direction (D).

2. The assembly (1) according to claim 1, wherein the circumferential wall (31) is provided with a support (34) for attaching the sheet (20).

3. The assembly (1) according to claim 2, wherein the support (34) is a ridge provided circumferentially along the circumferential wall (31).

4. The assembly (1) according to claim 2 or 3, wherein the support (34) extends over the full circumference of the circumferential wall (31).

5. The assembly (1) according to any of the claims 2 to 4, wherein the sheet (20) is attached to the support (34) by means of an adhesive (25).

6. The assembly (1) according to any of the claims 2 to 5, wherein the sheet (20) is a flat sheet.

7. The assembly (1) according to claim 6, wherein the opening (22) is a central opening remote from all

outer edges (24) of the sheet (20).

8. The assembly (1) according to any of the previous claims, wherein the circumferential wall (31) tapers in the first direction (D). 5
9. The assembly (1) according to any of the previous claims, wherein the sheet (20) is formed from a first material different from a second material, the circumferential wall (31) being formed of the second material. 10
10. The assembly (1) according to claim 9, wherein the second material is a plastic, preferably a liquid crystal polymer (LCP). 15
11. The assembly (1) according to claim 9 or 10, wherein the first material is a metal, preferably a transition metal, and very preferably comprises titanium (Ti). 20
12. The assembly (1) according to any of claims 9 to 11, wherein the third material is a ceramic, preferably comprising silicon carbide (SiC).
13. The assembly (1) according to any of the previous claims, wherein a plurality of droplet forming units (40) are mounted spaced apart from one another on the support body (50), and wherein each droplet forming unit (40) is individually surrounded by its respective cover member (10). 25 30
14. A cover member (10) for use in a print head assembly (1) according to any of the previous claims, comprising: 35
 - an endless, circumferential wall (31) extending in a first direction (D); and
 - a sheet (20) mounted on the circumferential wall (31), the sheet (20) further comprising a through-hole forming an opening (22). 40
15. A method for assembling a print head assembly (1), comprising the steps of:
 - mounting at least one droplet forming unit (40) 45 on a support body (50), such that the at least one droplet forming unit (40) protrudes from the support body (50) in a first direction (50);
 - attaching a sheet (20) comprising an opening (22) to a circumferential wall (31) to form a cover member (10); 50
 - mounting the cover member (10), such that the cover member (10) surrounds the at least one droplet forming unit (40), and that the opening (22) is aligned with nozzles (41) on a nozzle plate (42) of the droplet forming unit (40). 55

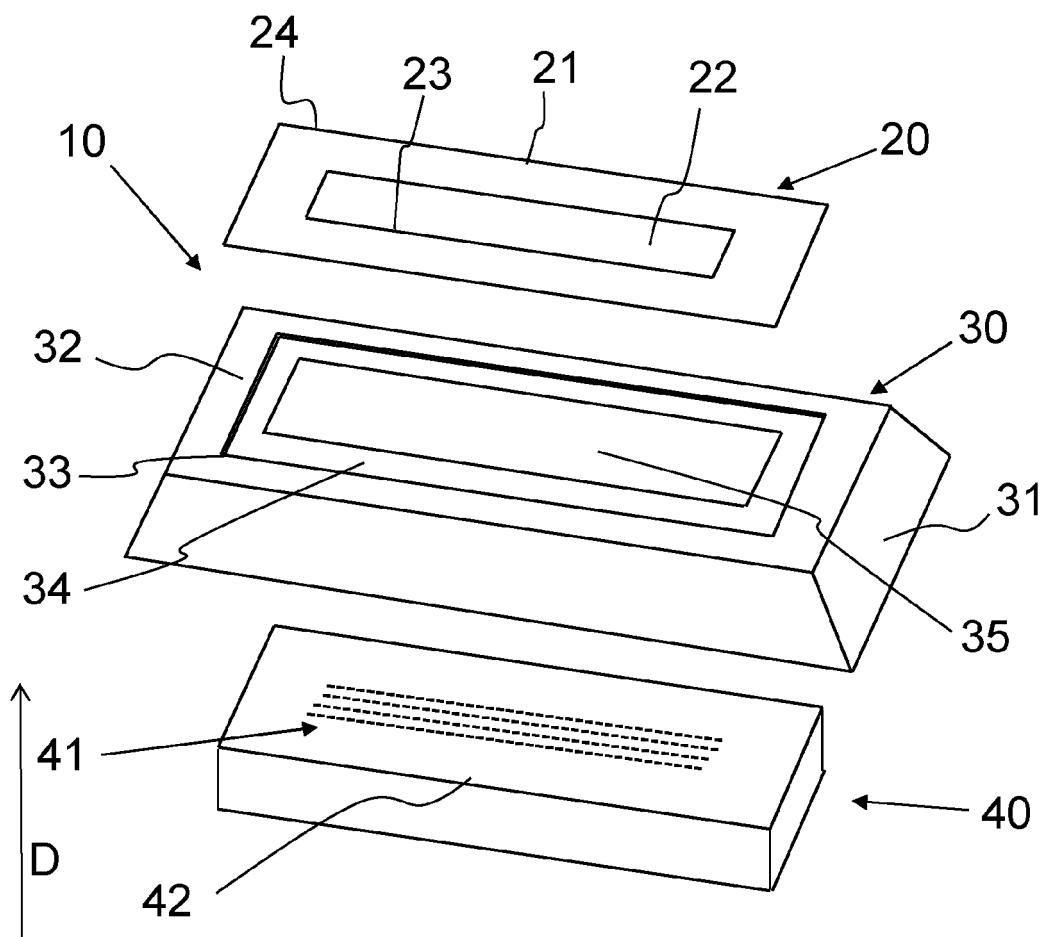


Fig. 1

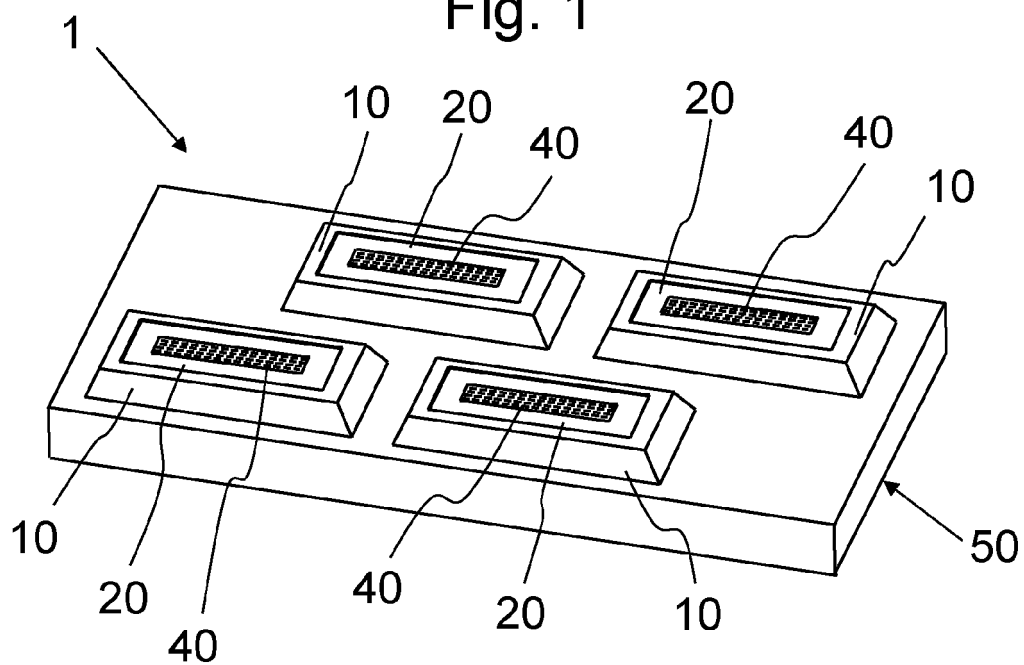
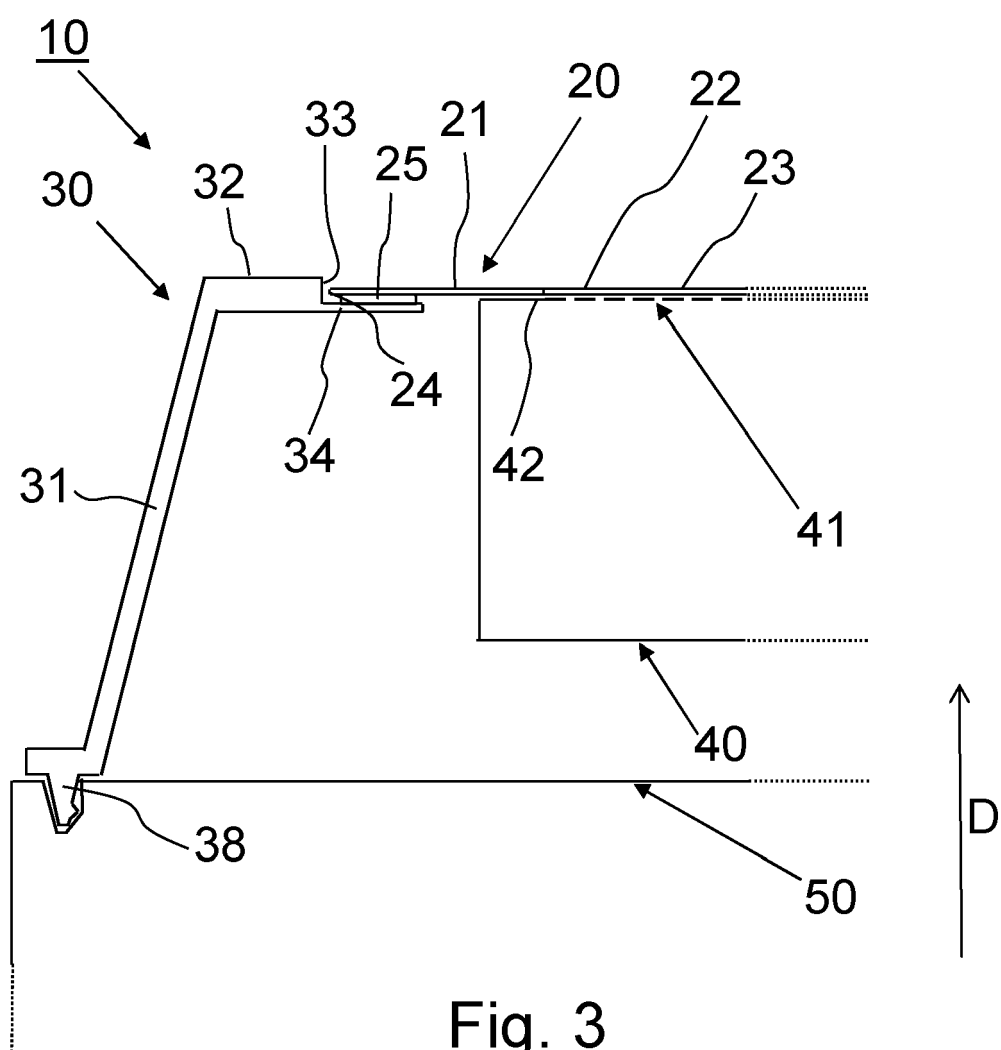


Fig. 2





EUROPEAN SEARCH REPORT

Application Number

EP 21 19 0675

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EPO FORM 1503 03.82 (P04C01)

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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 26 January 2022	Examiner Bardet, Maude
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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