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(71) Applicant: **Huawei Technologies Co., Ltd.**
Longgang District
Shenzhen, Guangdong 518129 (CN)

(72) Inventors:
- **Oelmez, Tekin**
  80992 Munich (DE)
- **Obermaier, Johann**
  80992 Munich (DE)
- **Yichao, Chen**
  80992 Munich (DE)

(74) Representative: **Kreuz, Georg Maria**
Huawei Technologies Duesseldorf GmbH
Riesstrasse 8
80992 München (DE)

(54) **Radiator for an antenna**

(57) The present invention provides a radiator 100 for an antenna, and an antenna comprising the radiator 100. The radiator 100 comprises a radiating element 101, which is made of a non-self-carrying sheet comprising at least a conductive surface. Further, the radiating element 101 comprises a non-conducting carrier 102, which is configured to hold in place the at least one radiating element 101. The radiating element 101 is connectable to the non-conductive carrier 102 such that the radiating element 102 follows at least one surface plane 103, 104 of the carrier 102. The radiator 100 may further comprise a feed 200 fittingly insertable into a feed slot 205 provided in the carrier 102, such that when the feed 200 is inserted in to the feed slot 205, a capacitive coupling between the feed 200 and the radiating element 101 is established.

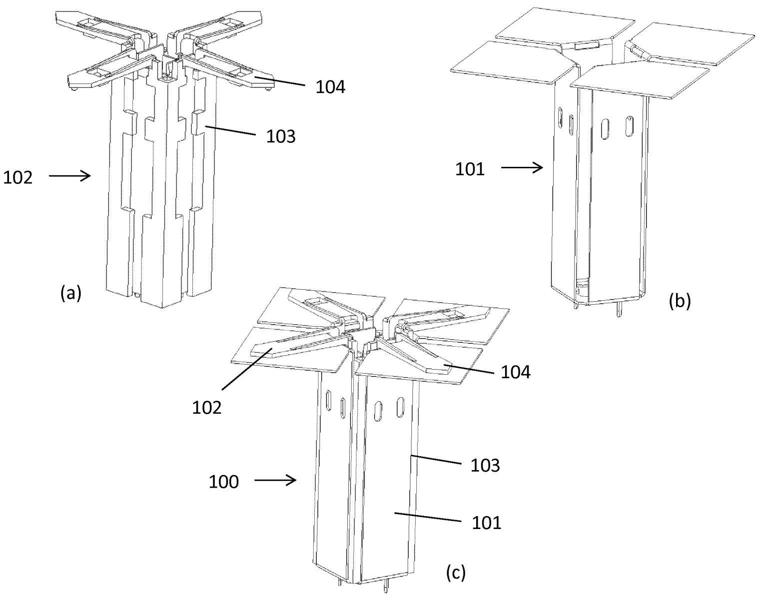

Fig. 1

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Description

TECHNICAL FIELD

[0001] The present invention relates to a radiator for an antenna, and to an antenna including said radiator. In particular, the design of the radiator bases on a separation of its electrical function and its mechanical supporting structure.

BACKGROUND

[0002] The performance of an antenna depends strongly on the RF performance of its radiator. For a good RF performance, the radiator requires a radiating element, for instance a dipole, which has at least about 10 μm of a conducting layer. Furthermore, geometrical tolerances of the radiator should be low, since they directly impact on its RF performance. In particular, the higher a radiating frequency of the radiator is desired to be, the smaller the geometrical tolerances need to be. The geometrical tolerance that most critically affects the RF performance of a radiator is a distance between the radiating element and a feed. Accordingly, for a good RF performance the distance between the radiating element and the feed has to be kept as constant as possible over at least a part of the radiating element.

[0003] While the above considerations are relevant for a good RF performance of the radiator, also manufacturing requirements have to be considered. For instance, the cost of the radiator, particularly of the used materials, is critical for high volume production of antennas. Also the weight of an assembled antenna, and thus the weight of the radiator in the antenna, should be as low as possible. Furthermore, the radiator of an antenna is typically connected to a distribution network, and therefore at least the conduction layer of the radiating element should be solderable.

[0004] Additionally, since antennas are typically designed for a rather long life time, the geometrical tolerances and the RF performance mentioned above should be achieved in different environmental conditions, i.e. should be resistant, for instance, to changing temperatures, high humidity, shocks caused e.g. by wind, or vibrations.

[0005] Conventional radiator designs for antennas are numerous. Radiating elements with different geometries, for instance cross-like, vector-like, square-like, or horn-like geometries, are known. Further, various material processing techniques are used. For instance, die-casted aluminum or zinc is used with electrochemical plating for making it solderable. Further, pre-plated sheets, which are stamped and bent are used, and also PCB assemblies or injection molded plastic with electrochemical or electroless plating are used. Also mechanical interface designs for fixation of radiators to reflectors, or electrical interface designs, are numerous. For instance, as an electrical interface of a RF radiator, cables or PCBs are used, which need to be solderable.

[0006] However, all conventional radiator designs suffer from the problem that the electrical function of the radiator, its dimensional stability, and its geometrical precision are all provided by the same parts. In general, this adds unnecessary weight to the radiator and makes it more costly. Another general problem is that any plating adds additional process steps to the production of a radiator, and may also be the cause for quality issues, for deviation between individual radiators, and may increase the costs.

[0007] A specific example of a conventional radiator employs a plastic dipole. The radiator is injection molded at high temperature, and its material is fiber reinforced plastic. However, this material is rather expensive. Furthermore, conducting layers have to be applied by electroless or electrochemical plating, which both suffer from a high error rate, are expensive, and add considerable weight to the radiator. The weight of such a radiator is comparable to the weight of a conventional radiator manufactured by aluminum die-casting.

[0008] Another specific example of a conventional radiator is PCB-based. However, the assembly of several PCBs with dipole and feed structures is necessary, but is rather complicated and cost intensive.

[0009] Yet another example of a conventional radiator uses a die-casted dipole. For this radiator, the geometry, the conducting layer, and the supporting structure are all provided in one part. The radiator thus has a high weight, due to a certain wall thickness required for the die-casting process. Additionally, an electrochemical plating process must be applied, which has a rather high error rate, adds weight, and is expensive.

[0010] A final example of a conventional radiator includes a sheet metal dipole, wherein the geometry and the supporting structure of the radiator are provided by the same part. The sheet metal dipole has a high weight, due to a certain wall thickness that is necessary for its stability. The radiator is furthermore only suitable for low band applications, due to a limited precision for the manufacturing of its bended parts.

SUMMARY

[0011] In view of the above-mentioned disadvantages, the present invention aims to improve the conventional radiator designs. The present invention has accordingly the object to provide a cheaper and lighter radiator with improved RF performance. In particular, the present invention aims for a high manufacturing precision of the radiator geometry, so that the radiator is good enough for high band applications. Accordingly, the present invention aims specifically for a low geometrical tolerance of a distance between a radiating element and a feed of the radiator. The weight and the cost of the radiator should be suited for high volume production. Moreover, the radiator should be solderable, sturdy, and resistant against mechanical vibrations.

[0012] The above-mentioned object of the present invention is achieved by the solution provided in the enclosed independent claims. Advantageous implementations of the present invention are further defined in the dependent claims.

[0013] In particular the present invention proposes a radiator, in which the electrical function, i.e. the actual radiating function of the radiator, is separated from a mechanical supporting structure of the radiator. To this end, the idea of the present invention is to use a cheap but very precise mechanical carrier part, in order to provide to the radiator a shape and geometry with very small geometrical tolerances, and at the same time to use a thin walled, unstable sheet (having at least a conducting surface or being made from conductive material), in order to provide the radiating element.

[0014] A first aspect of the present invention provides a radiator for an antenna, the radiator comprising a radiating element being made of a non-self-carrying sheet comprising at least a conductive surface, a non-conducting carrier configured to hold in place the at least one radiating element, wherein the radiating element is connectable to the non-conductive carrier such that the radiating element follows at least one surface plane of the carrier.

[0015] The radiator of the first aspect realizes the general idea of embodiments of the present invention, namely to separate the electrical and the mechanical functions of the radiator. In particular, the non-conductive carrier provides the mechanical function of the radiator, i.e. it provides the radiator with its mechanical stability, defines its shape and geometry, and sets its dimensions with very small geometrical tolerances. The carrier achieves in particular a precise positioning of the radiating element, for instance relative to a feed. Thus, the RF performance of the radiator is improved. The carrier can be manufactured very precisely, while being still relatively cheap and sturdy. The carrier is also light of weight. The radiating element provides the electrical function, i.e. it provides the radiator with its actual radiating ability. Since the radiating element is a non-self-carrying sheet, it is comparatively cheap in production, and is light of weight. Due to the individual advantages of its components, the radiator as a whole is suitable for high volume production, is comparatively cheap, very light of weight, and has excellent RF performance.

[0016] In a first implementation form of the radiator of the first aspect, the radiator further comprises a feed which is fittingly insertable into a feed slot provided in the carrier such that when the feed is inserted in to the feed slot, a capacitive coupling between the feed and the radiating element is established.

[0017] Therefore, the distance between the radiating element and the feed is defined completely by the geometry of the carrier and has accordingly a very low tolerance. Consequently, the RF performance of the radiator is improved in view of conventional radiators, and the radiator is particularly well suited for high-frequency applications.

[0018] In a second implementation form of the radiator according to the first aspect as such or according to the first implementation form of the first aspect, the radiating element is connectable to at least two surface planes of the carrier.

[0019] The at least two surface planes provide a stable connection between the radiating element and the carrier. The radiating element may be a dipole with two dipole arms, wherein each dipole arm is connected to at least one surface plane.

[0020] In a third implementation form of the radiator according to the first aspect as such or according to any previous first implementation form of the first aspect, a first part of the radiating element tightly follows a first surface plane of the carrier, when said radiating element is connected to the carrier, and the first surface plane has a substantially constant distance to a feed slot of the carrier.

[0021] For a good RF performance of the radiator, it is advantageous that the first part of the radiating element, which may be a first dipole arm of a dipole, has a constant distance to the feed. Since the carrier can be manufactured with high precision, the distance between the first surface plane and the feed slot can be provided with low tolerance. As a consequence, also the distance between the first part of the radiating element and the feed can be defined very precisely. Therefore, the RF performance of the radiator is improved.

[0022] In a fourth implementation form of the radiator according to the first aspect as such or according to any previous first implementation form of the first aspect, a gap is provided between a second surface plane of the carrier and a second part of the radiating element, wherein the gap is chosen such that at least in a temperature range from -55°C to 85°C an undesired contact in the area of the gap between the radiating element and the carrier caused by thermal expansion is avoided.

[0023] The gap is provided to avoid that due to different thermal expansion coefficients of the radiating element and the carrier, the preciseness of the geometrical dimensioning, and in particular the distance between the radiating element and the feed, deteriorates when the temperature changes.

[0024] In a fifth implementation form of the radiator according to the first aspect as such or according to any previous first implementation form of the first aspect, the radiating element and/or the feed of the radiator is made of a metal sheet having a thickness of about 0.1 to 2 mm, preferably about 0.5 to 1 mm.

[0025] The thin metal sheet can be produced comparatively cheap, and is very light of weight. The metal sheet can also be soldered well. Preferably, the metal sheet is a hot dip plated metal sheet.

[0026] In a sixth implementation form of the radiator according to the fourth or fifth implementation form of the first aspect, the radiating element follows the first surface plane from a bottom part of the carrier to a top part of the carrier, and follows the second surface plane outwardly from at the top part of the carrier. Preferably the first surface plane and the second surface plane are substantially perpendicular to another.

[0027] Thereby, a radiating element with good RF performance can be provided in the radiator.

[0028] In a seventh implementation form of the radiator according to the first aspect as such or according to any previous first implementation form of the first aspect, the carrier consists of one integrally formed part.

[0029] An integrally formed part is very easy and cheap to manufacture, and provides the best sturdiness.

[0030] In an eighth implementation form of the radiator according to the seventh implementation form of the first aspect, the radiating element is connectable to a first surface plane of the carrier by at least one protruding element provided on the carrier.

[0031] The protruding element may, for instance, be a knob, onto which the radiating element may be clipped. Accordingly, the radiating element may have a suitable counterpart, for instance, an opening or slot. Preferably, a snap fit is provided between the protruding element and the radiating element for a tight fit of the radiating element to the carrier.

[0032] In a ninth implementation form of the radiator according to the eighths implementation form of the first aspect, the at least one protruding element is configured to partly twist said radiating element to form a spring pressing at least a part of the radiating element against the carrier.

[0033] Due to the twist, the radiating element is pressed towards the carrier, so that the radiating element, at least the pressed part thereof, follows tightly a surface plane of the carrier. Thus, the positioning of the radiating element is very precise, in particular relative to the feed.

[0034] In a tenth implementation form of the radiator according to the eighth or ninth implementation form of the first aspect, the radiating element is connectable to a second surface plane of the carrier by an undercut provided on the carrier.

[0035] The radiating element may be easily attached to the carrier by the undercut. For instance, a snap fit between the undercut and the radiating element may be provided. The snap fit connection may have some play, in order to allow for a thermal expansion of the radiating element and/or the carrier, respectively.

[0036] In an eleventh implementation form of the radiator according to the first aspect as such or according to any previous first implementation form of the first aspect, the carrier comprises an inner part and an outer part, and the inner part and the outer part are connectable to each other for holding in between the radiating element.

[0037] With the two-part carrier, the sheet-like radiating element can be held in place very securely, because it is fixed from both sides. The two parts of the carrier are easy to manufacture and also easy to assemble.

[0038] In a twelfths implementation form of the radiator according to the eleventh implementation form of the first aspect, the inner part is provided with an arm, and the radiating element is pressed by the arm against the outer part, when the inner part and the outer part are connected to each other.

[0039] The arm holds the radiating element securely against the outer part of the carrier, so that the radiating element follows tightly a surface plane of the carrier. Thus, the positioning of the radiating element within the radiator is very precise and stable.

[0040] In a thirteenth implementation form of the radiator according to the twelfths implementation form of the first aspect, the radiator further comprises a feed, wherein the arm is provided with at least one spring, and the feed is pressed by the at least one spring against the inner part, when the inner part and the outer part are connected to each other.

[0041] Preferably, the arm has a lower stiffness than the spring. The arm has a twofold function, i.e. it firstly presses the radiating element against the outer part, and it secondly presses the feed against the inner part. That means that the accurateness of the distance between the radiating element and the feed is mainly defined by the geometry and the elastic properties of the arm. Since the arm can be manufactured very precisely, the radiator can be provided with an excellent RF performance even at high operating frequencies.

[0042] A second aspect of the present invention provides an antenna comprising at least one radiator according to the first aspect as such or according to any implementation form of the first aspect.

[0043] The antenna of the second aspect inherits all advantages of the radiator of the first aspect as such or its implementation forms, which have been described above.

[0044] It has to be noted that all devices, elements, units and means described in the present application could be implemented in the software or hardware elements or any kind of combination thereof. All steps which are performed by the various entities described in the present application as well as the functionalities described to be performed by the various entities are intended to mean that the respective entity is adapted to or configured to perform the respective steps and functionalities. Even if, in the following description of specific embodiments, a specific functionality or step to be full formed by eternal entities is not reflected in the description of a specific detailed element of that entity which performs that specific step or functionality, it should be clear for a skilled person that these methods and functionalities can be implemented in respective software or hardware elements, or any kind of combination thereof.

BRIEF DESCRIPTION OF DRAWINGS

[0045] The above described aspects and implementation forms of the present invention will be explained in the following description of specific embodiments in relation to the enclosed drawings, in which

Fig. 1 shows a radiator according to a basic embodiment of the present invention.

Fig. 2 shows in (a) a feed, and in (b) a radiator according to a first specific embodiment of the present invention having the feed inserted.

Fig. 3 shows a carrier according to a second specific embodiment of the present invention.

Fig. 4 shows a section view of the radiator according to the second specific embodiment of the present invention.

Fig. 5 shows a further section view of the radiator according to the second specific embodiment of the present invention.

Fig. 6 shows a bottom view of the radiator according to the second specific embodiment of the present invention.

Fig. 7 shows a further bottom view of the radiator according to the second specific embodiment of the present invention.

Fig. 8 shows a further bottom view of the radiator according to the second specific embodiment of the present invention.

Fig. 9 shows further section views of the radiator according to the second specific embodiment of the present invention.

DETAILED DESCRIPTION OF EMBODIMENTS

[0046] Figure 1 illustrates in (c) a radiator 100 for an antenna according to a basic embodiment of the present invention. The radiator 100 comprises a radiating element 101 shown in (b), which is made of a non-self-carrying (e.g. thin metal) sheet comprising at least a conductive surface. For instance, the radiating element 101 may be made of a metal sheet, in particular of a thin-walled, unstable metal sheet. The radiating element 101 may be a dipole, and/or may for instance have a cross-shape as shown in (b) of Fig. 1 (and in all following figures). A cross-shaped radiating element 101 comprises of four substantially identical metal sheet sections, which are arranged in a cross-like manner. However, the shown cross-shape is only an example, and the radiating element 101 can have other shapes, like a vector-, square-, or horn-shape. The description of the figures in the following is given mainly with respect to one metal sheet section, but is preferably identical for the other sections.

[0047] The radiator 100 further comprises a non-conducting (e.g. plastic) carrier 102 shown in (a), which is configured to hold in place the radiating element 101 in the assembled state of the radiator 100 shown in (c). The radiator 100 may also have more than one radiating element 101, and the carrier 102 may thus be configured to hold in place a plurality of radiating elements 101. The carrier 102 is, for example, made of a plastic material, and can be produced cheap and precisely, for instance, by injection molding or by 3D printing.

[0048] The radiating element 101 is connectable to the carrier 102, such that the radiating element 101 follows at least one surface plane 103, 104 of the carrier 102 in the assembled state as shown in (c). For assembling the radiator 100, the carrier 102 may be inserted into the radiating element 101, or the radiating element 101 may be inserted into the carrier 102. A connection between the radiating element 101 and the carrier 102 is preferably such that the radiating element 101 follows at least one surface plane 103 of the carrier 102 tightly. That means that the radiating element 101 preferably touchingly follows the surface plane 103, and that the geometry and preciseness of the surface plane 103 is transferred to the radiating element 101.

[0049] As can be seen in Fig. 1 and also the following figures a first surface plane 103 of the carrier 102 extends from a food or bottom part of the carrier (where it may be mounted to an antenna board) to a top part of the carrier. A second surface plane 104 extends at the top of the carrier outwards from a center axis of the carrier 102 (in this and the following shown embodiments in 4 directions - cross like structure). The radiator 102 is chosen such that it (at least partly) follows these surface planes 103, 104.

[0050] Fig. 2 shows in (b) a radiator 100 designed according to a first specific embodiment of the present invention, which bases on the basic embodiment shown in Fig. 1. In the first specific embodiment of the present invention, the carrier 102 consists of one integrally formed part. For assembling the radiator 100, the radiating element 101 is inserted into this one-part carrier 102.

[0051] Fig. 2 shows in (a) a feed 200, which may further be part of the radiator 100. In particular, Fig. 2 shows in (b) the radiator 100 with inserted feed 200. To this end, the carrier 102 is provided with a feed slot 205, so that the feed 200 can be fittingly inserted. In the assembled state of the radiator 100 shown in (b), a first part 206 of the inserted radiating element 101 follows tightly a first surface plane 103 of the carrier 102. The first surface plane 103 has a substantially constant distance to the feed slot 205, so that at least over the length of the first part 206 of the radiating element 101, a constant distance from the radiating element 101 to an inserted feed 200 is provided in the assembled state of the radiator 100. In the assembled state, the feed 200 and the radiating element 101 are further able to couple capacitively to each other.

[0052] In order to connect the radiating element 101 to the carrier 102, such that the first part 206 of the radiating element 101 tightly follows the first surface plane

103, the carrier 102 is preferably provided with at least one protruding element 203, which may be for instance a knob. The protruding element 203 is preferably configured to partly twist the inserted radiating element 101, in order to form a spring 204 in at least a part of the radiating element 101, which is suited to press at least a part of the radiating element 101 tightly against the carrier 102.

[0053] Fig. 2 shows further in (b) that a second part 207 of the inserted radiating element 101 is connected to the second surface plane 104 of the carrier 102. The second surface plane 104 may therefore be provided with an undercut 202, with which the second part 207 of the radiating element 101 can be connected to the carrier 102.

[0054] The second part 207 of the radiating element 101 may particularly be connected in such a way to the second surface plane 104 of the carrier 102 that a gap 201 is provided between the second surface plane 104 and the second part 207. The gap 201 allows the radiating element 101 to move relative to the carrier 102 in case of a thermal expansion, and particularly in case that the thermal expansion coefficients of the carrier 102 and the radiating element 101 are different. In particular, the dimensions of the gap 201 are selected depending on the thermal expansion coefficients of the carrier 102 and the radiating element 101. Preferably, the gap 201 should allow the radiating element 101 to thermally expand, so that in a temperature range from at least -55 °C to 85 °C an undesired contact between the radiating element 101 and the carrier 102, which is caused by thermal expansion, is avoided.

[0055] Fig. 3 shows a carrier 102 as used for a radiator 100 according to a second specific embodiment of the present invention. In the second specific embodiment of the present invention, which bases also on the basic embodiment shown in Fig. 1, the carrier 102 is not an integrally formed part, but comprises an inner part 301 and an outer part 302.

[0056] The inner part 301 and the outer part 302 are connectable to each other, in order to sandwich in between the radiating element 101. That means, for assembling the radiator 100, the radiating element 101 is inserted into the carrier 102. In Fig. 3 the outer part 301 and inner part 302 are shown connected to each. A recess 303 in at least the outer part 302 is visible, which is intended to provide an air gap for a better capacitive coupling between the radiating element 101 and the feed 200 in the assembled state of the radiator 100. Such a recess 303 in the carrier 102 for a better capacitive coupling of the radiating element 101 and the feed 200 can also be provided to the one-part carrier 102 in the first specific embodiment.

[0057] Fig. 4 shows a radiator 100 according to the second specific embodiment. The outer part 302 and the inner part 301 of the carrier 102 can be seen, which hold in between the radiating element 101. Like for the first specific embodiment, a first part 206 of the radiating element 101 follows a first surface plane 103 of the carrier 102 tightly, and a second part 207 of the radiating element 101 follows a second surface plane 104 of the carrier 102. In the second specific embodiment, the first part 206 of the radiating element 101 is pressed tightly onto the outer part 302 by the inner part 301, so that a distance between the first part 206 and the feed 200, when it is inserted into the feed slot 205 of the carrier 102, is substantially constant. In particular, there is preferably created a constant gap 402, over which the first part 206 of the radiating element 101 and the feed 200 can capacitively couple to another. In the second specific embodiment, again also a gap 201 is provided between the second part 207 of the radiating element 101 and the second surface plane 104, in order to allow for thermally caused relative movements of the individual components of the radiator 100.

[0058] Fig. 5 shows a different view of the radiator 100 according to the second specific embodiment. Fig. 5 specifically illustrates that for assembling the inner part 301 and the outer part 302, in order to hold in between the radiating element 101 and the feed 200, firstly the inner part 301 may be inserted downwardly into the outer part 302, and may be secondly pushed outwardly against the outer part 302, in order to tightly secure in between the first part 206 and the second part 207 of the radiating element 101 and the feed 200. Preferably, the outer part 302 and the inner part 301 of the carrier 102 may thereby be snapped together by a suitable snap fit mechanism. Of course the inner part 301 and the outer part 302 may also be connected to each other by any other suitable attachment mechanism, for example by screws, a clip fit, glue or the like.

[0059] Fig. 6 shows a view from below the radiator 100 according to the second specific embodiment. In a lower part of the radiator 100, the inner part 301 and the outer part 302 of the carrier 102 hold the feed 200 and the radiating element 101, respectively, in a well-defined position, i.e. with a substantially constant distance to each other. The radiating element is held against the first surface plane 103. In an upper part of the radiator 100, the second surface plane 104 is used for guiding the radiating element 101 outwardly. Here the radiating element 101 is held less tight, so that it can move relatively to the carrier 102.

[0060] A bottom view of the radiator 100 is also shown in Fig. 7. Fig. 7 specifically shows that the inner part 301 of the carrier 102 is provided with one or more arms 700 configured to press the radiating element 101 from the inside to an inner surface of the outer part 302, in order to hold it at a substantially constant distance to the feed 200. Thereby, one or more arms may be used for different sections of the radiating element 101.

[0061] For instance, as shown in Fig. 8, for the exemplary cross-like radiating element 101 with four sections 101a, 101b, 101c and 101d, a plurality of arms 700 may be provided per section on the inner part 301 of the carrier 102, in order to press the radiating element 101 against in total four surface planes 103a, 103b, 103c, 103d of the outer part 302. That means, each section 101a, 101b, 101c and 101d is pressed to a different surface plane 103a, 103b, 103c or 103d, and each section is thus provided with a substantially constant distance to the feed 200. The above applies of course also to the first specific embodiment.

[0062] In Fig. 8 can also be seen that at least one spring element 800 of the outer part 302 presses the feed 200 to an outer surface of the inner part 301. As shown in Fig. 8, the radiating element 101 preferably has therefore an opening, through which the spring element 800 of the outer part 302 can extend, in order to press on the feed 200. Multiple spring elements 800 can be provided, for example, depending on the shape of the radiating element 101 and the feed 200.

[0063] Finally, Fig. 9 shows an enlarged view of the radiator 100 according to the second specific embodiment. In particular, Fig. 9 shows that each arm 700 is preferably provided with at least one spring 900, which presses the feed 200 against the inner part 301 of the carrier 102, when the arm 700 presses the radiating element 101 to the outer part 302 of the carrier 102. The spring 900 has preferably a lower stiffness than the arm 700. Furthermore, the outer part 302 has preferably a lower stiffness than the arm 700, or as the inner part 301 in general. In Fig. 9 can also be seen that by means of the arm 700 and the spring 900, the radiating element 101 and the feed 200 are held in place with a well determined distance 901, which depends mainly on the constructional preciseness of the arm 700 and the spring 900, respectively. Since the whole inner element 301, including the arm 700 and the spring 900, can be manufactured very precisely, for instance by injection molding or 3D printing, the distance 901 can be defined with low geometrical tolerances over a relatively large surface area.

[0064] In particular, the arm 700 provided on the inner part 301 of the carrier 102 presses the radiating element 101 against the outer part 302 of the carrier 102, wherein the outer part 302 is elastic enough to follow the dimensions and tolerances of the inner part 301. The spring 900 on the arm 700 of the inner part 301 presses simultaneously the feed 200 against the inner part 301. This design guarantees an almost tolerance free distance 901 between the feed 200 and the radiating element 101.

[0065] In summary, embodiments of the present invention provide advantages to a radiator 100, which are achieved by separation of its electrical and mechanical functions. The mechanical supporting structure of the radiator 100 can be produced with high preciseness and low cost. Additionally, the electrical part of the radiator 100 can be produced with low weight, due to its reduced thickness, low cost, and is able to follow exactly the precise mechanical structure. Accordingly, a distance between the radiating element 101 and the feed 200 of the radiator 100, which distance is crucial for a good RF performance of the radiator 100, can be provided with low tolerance. Thus, the radiator 100 according to embodiments of the present invention is well suited for high frequency applications.

[0066] The present invention has been described in conjunction with various embodiments as examples as well as implementations. However, other variations can be understood and effected by those persons skilled in the art and practicing the claimed invention, from the studies of the drawings, this disclosure and the independent claims. In the claims as well as in the description the word "comprising" does not exclude other elements or steps and the indefinite article "a" or "an" does not exclude a plurality. A single element or other unit may fulfill the functions of several entities or items recited in the claims. The mere fact that certain measures are recited in the mutual different dependent claims does not indicate that a combination of these measures cannot be used in an advantageous implementation.

Claims

1. Radiator (100) for an antenna, the radiator (100) comprising
a radiating element (101) being made of a non-self-carrying sheet comprising at least a conductive surface,
a non-conducting carrier (102) configured to hold in place the at least one radiating element (101),
wherein the radiating element (101) is connectable to the non-conductive carrier (102) such that the radiating element (102) follows at least one surface plane (103, 104) of the carrier (102).

2. Radiator (100) according to claim 1, further comprising:

a feed (200) which is fittingly insertable into a feed slot (205) provided in the carrier (102) such that when the feed (200) is inserted in to the feed slot (205), a capacitive coupling between the feed (200) and the radiating element (101) is established.

3. Radiator (100) according to claim 1 or 2, wherein the radiating element (101) is connectable to at least two surface planes (103, 104) of the carrier (102).

4. Radiator (100) according to one of the preceding claims, wherein
a first part (206) of the radiating element (101) tightly follows a first surface plane (103) of the carrier (102), when said radiating element (101) is connected to the carrier (102), and
the first surface plane (103) has a substantially constant distance to a feed slot (205) of the carrier (102).

5. Radiator (100) according to one of the claims 1 to 4, wherein a gap (201) is provided between a second

surface plane (104) of the carrier (102) and a second part (207) of the radiating element (101),
wherein the gap (201) is chosen such that at least in a temperature range from - 55°C to 85°C an undesired contact in the area of the gap (201) between the radiating element (101) and the carrier (102) caused by thermal expansion is avoided.

6. Radiator (100) according to one of the claims 1 to 5, wherein the radiating element (101) or a feed (200) of the radiator (100) is made of a metal sheet having a thickness of about 0.1 to 2 mm, preferably about 0.5 to 1 mm.

7. Radiator (100) according to claim 5 or 6, wherein the radiating element (101) follows the first surface plane (103) from a bottom part of the carrier (102) to a top part of the carrier (102), and follows the second surface plane (104) outwardly at the top part of the carrier (102).

8. Radiator (100) according to one of the claims 1 to 7, wherein the carrier (102) consists of one integrally formed part.

9. Radiator (100) according to claim 8, wherein the radiating element (101) is connectable to a first surface plane (103) of the carrier by at least one protruding element (203) provided on the carrier (102).

10. Radiator (100) according to claim 9, wherein the at least one protruding element (203) is configured to partly twist said radiating element to form a spring (204) pressing at least a part of the radiating element (101) against the carrier (102).

11. Radiator (100) according to claim 9 or 10, wherein radiating element (101) is connectable to a second surface plane (104) of the carrier by an undercut (202) provided on the carrier (102).

12. Radiator (100) according to one of the claims 1 to 7, wherein
the carrier (102) comprises an inner part (301) and an outer part (302), and
the inner part (301) and the outer part (302) are connectable to each other for holding in between the radiating element (101).

13. Radiator (100) according to claim 12, wherein
the inner part (301) is provided with an arm (700), and the radiating element (101) is pressed by the arm (700) against the outer part (302), when the inner part (301) and the outer part (302) are connected to each other.

14. Radiator (100) according to claim 13,
further comprising a feed (200);
wherein the arm (700) is provided with at least one spring (900), and
the feed (200) is pressed by the at least one spring (900) against the inner part (301), when the inner part (301) and the outer part (302) are connected to each other.

15. Antenna comprising at least one radiator (100) according to one of the claims 1 to 14.

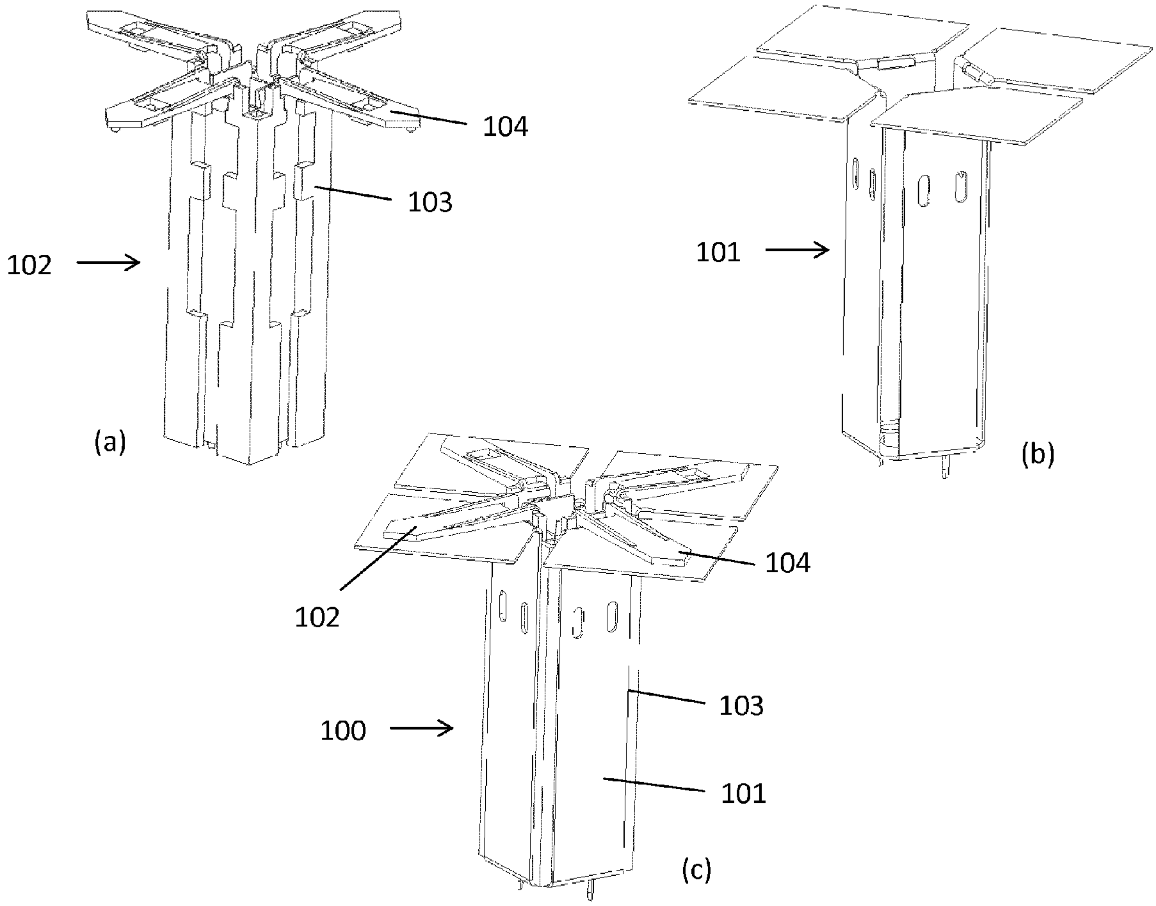

Fig. 1

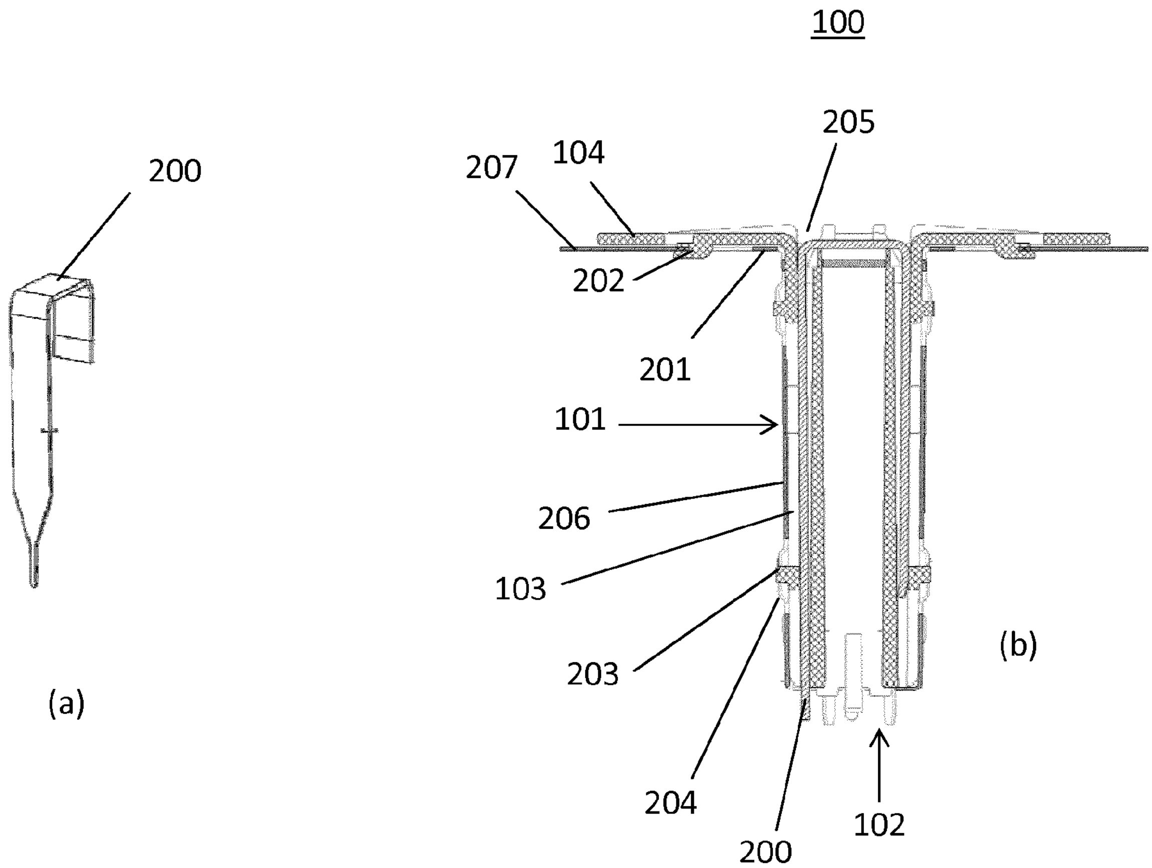

Fig. 2

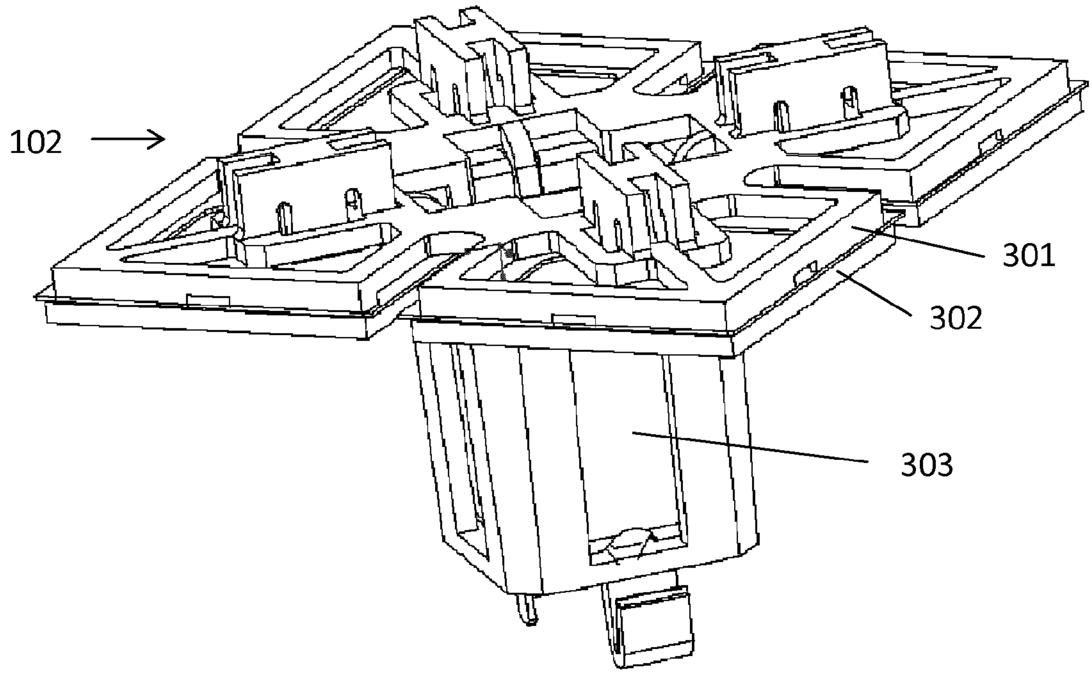

Fig. 3

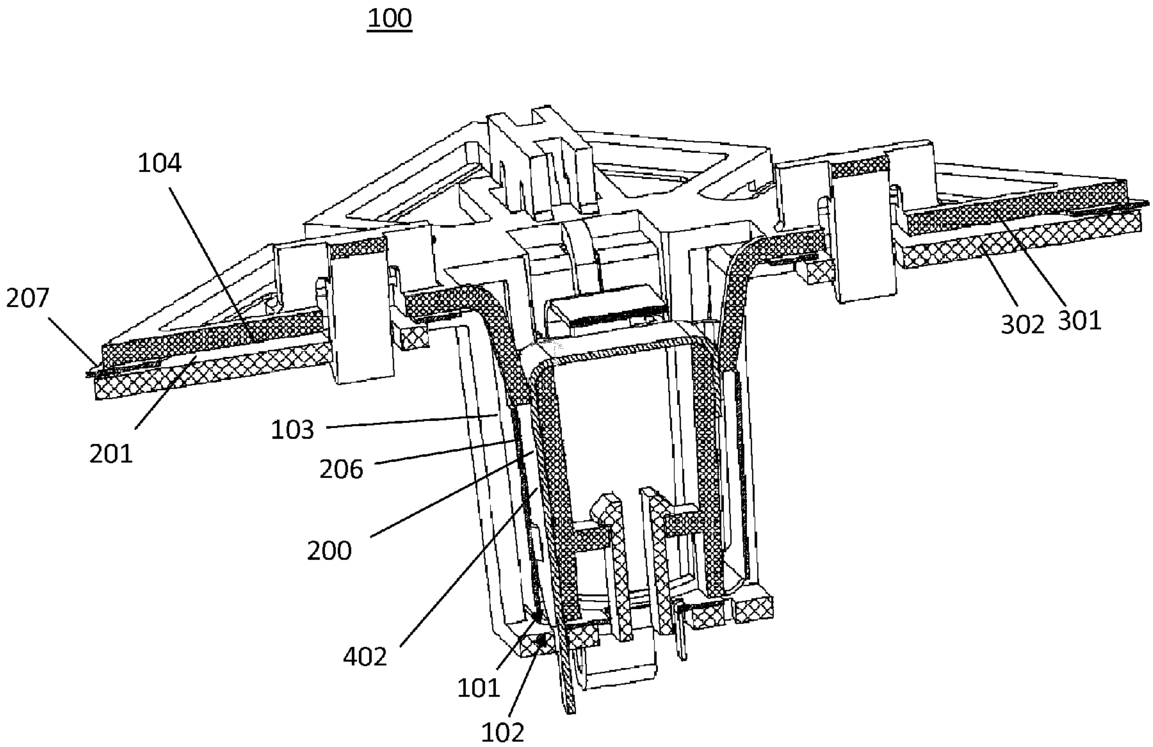

Fig. 4

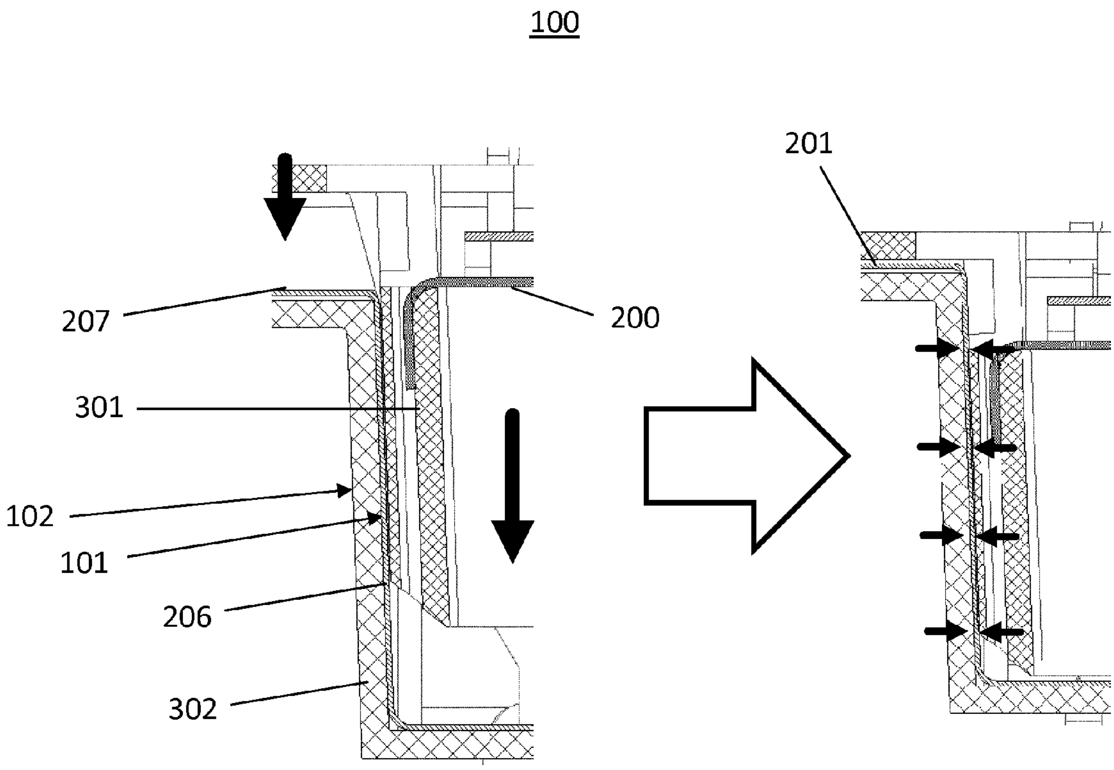

Fig. 5

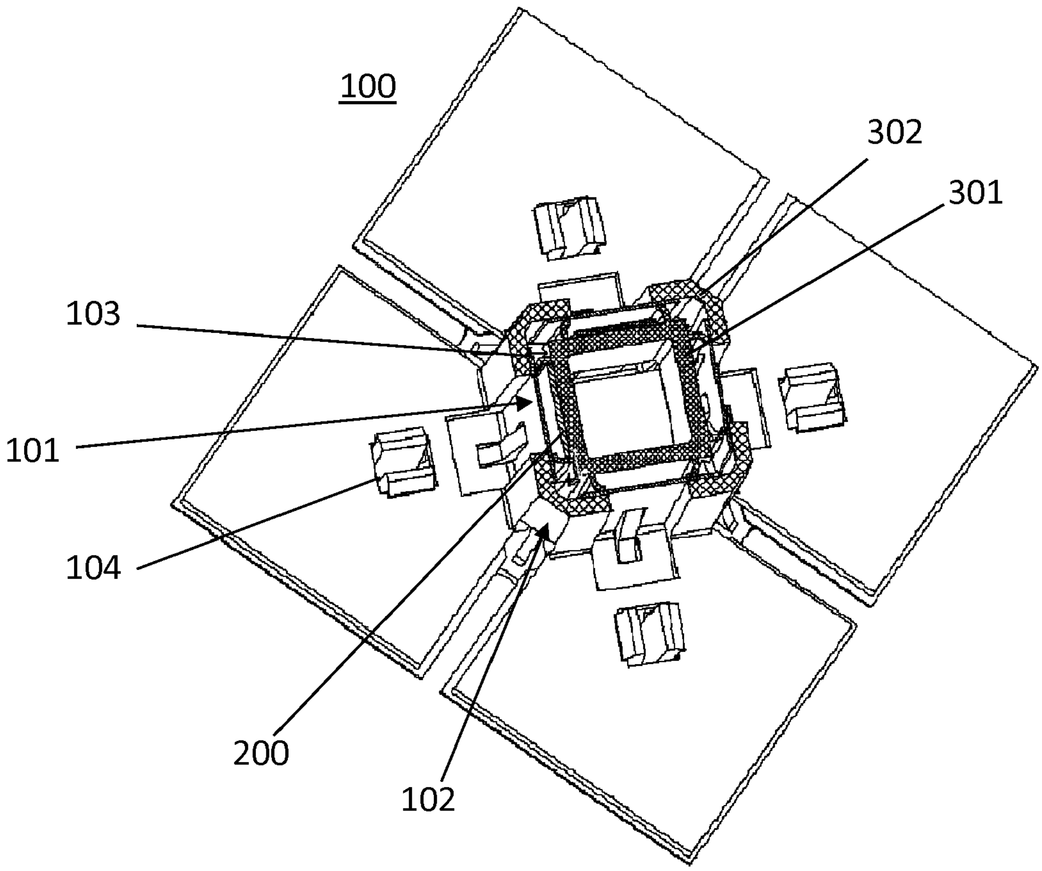

Fig. 6

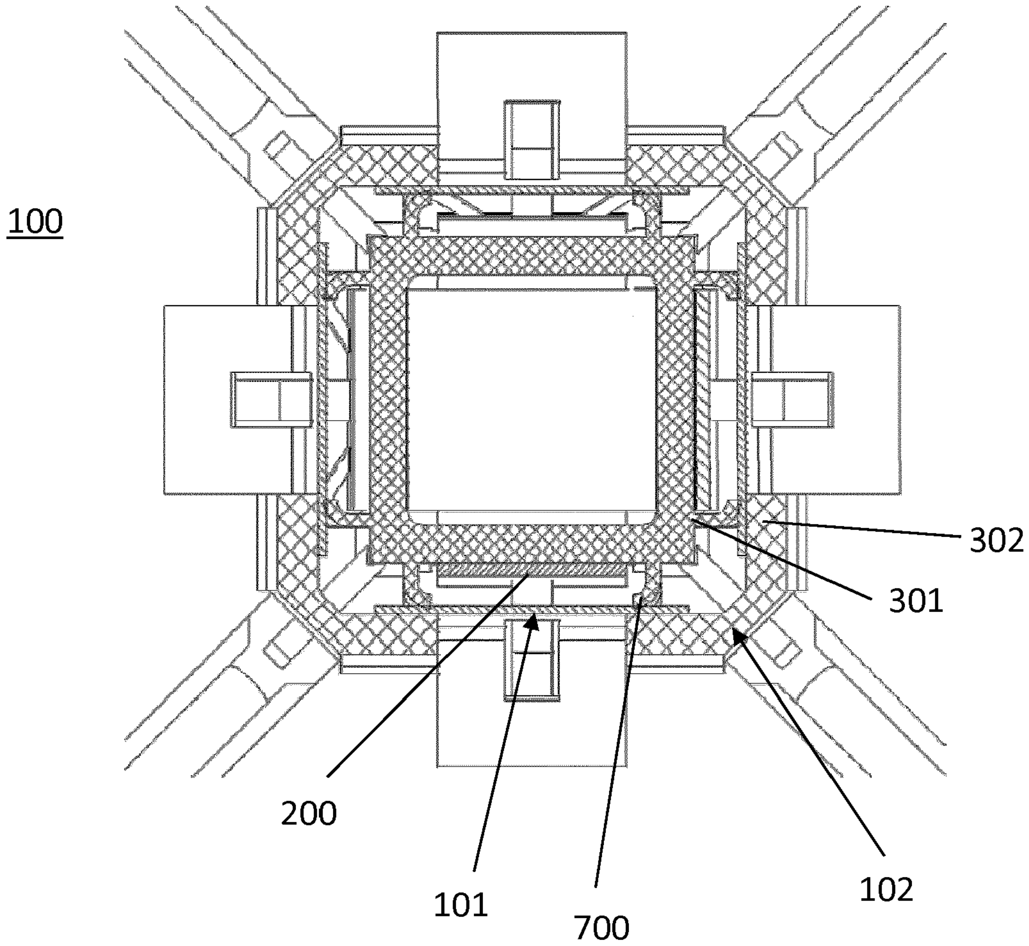

Fig. 7

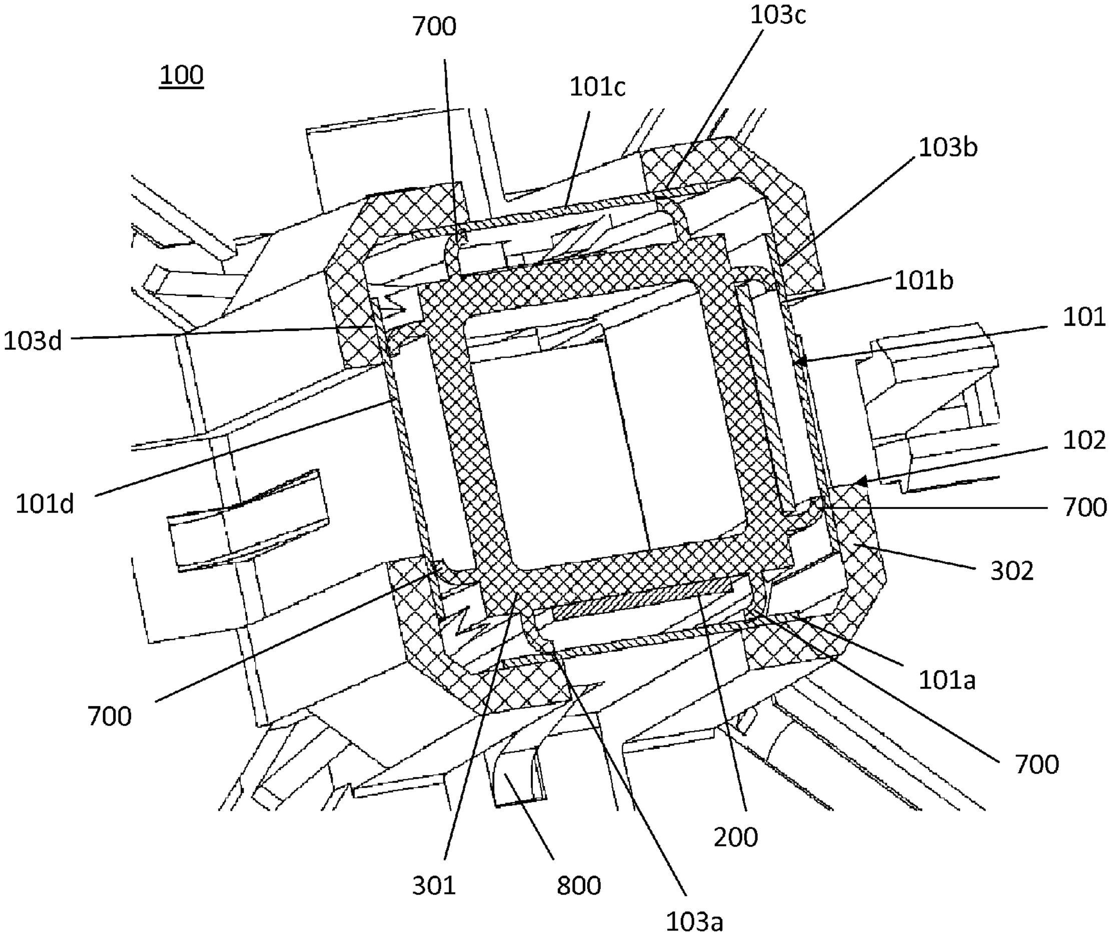
100
700
103c
101c
103b
101b
101
103d
102
101d
700
302
700
101a
700
200
301
800
103a

Fig. 8

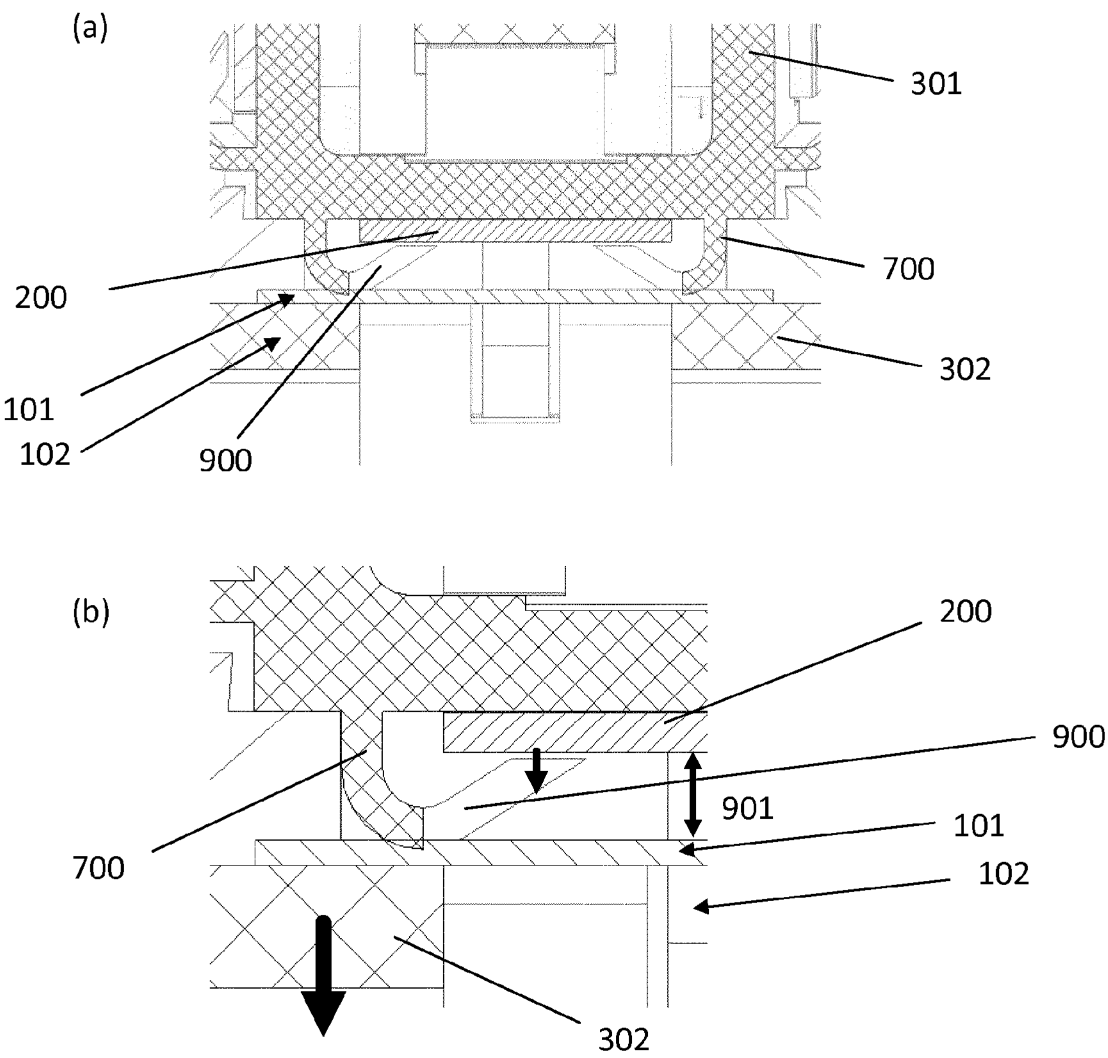

Fig. 9

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EUROPEAN SEARCH REPORT

Application Number
EP 14 19 8718

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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			H01Q

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	29 May 2015	Moumen, Abderrahim

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