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

(11) EP 2 500 978 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
10.07.2013 Bulletin 2013/28

(51) Int Cl.:
H01P 5/08 *(2006.01)* ***H01P 5/107*** *(2006.01)*

(21) Application number: **11158700.2**

(22) Date of filing: **17.03.2011**

(54) **Waveguide transition**

Wellenleiterübergang

Transition de guide d'onde

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

(43) Date of publication of application:
19.09.2012 Bulletin 2012/38

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to the field of radio frequency communication, and more particularly to a transition between a microstrip and a waveguide.

BACKGROUND OF THE INVENTION

[0002] Wireless transmission of a radio frequency signal generally requires delivering the signal carrying considerable power to the transmission antenna, which is best obtained by means of a conventional rectangular waveguide, i.e. a rectangular tube, connected with the antenna. Similarly, when receiving a signal as well it is advantageous to have a recatangular waveguide attached to the antenna, since it has the lowest attenuation of the presently available alternatives. It should be noted that for the purposes of this application the term "waveguide" used alone means such a conventional rectangular waveguide. However, in order to perform signal processing of the signal before transmission, a circuit board environment is preferred, employing inter alia microstrips. It is a complex matter to transfer the signal from a microstrip to a waveguide, and vice versa, and there are some different ways of arranging a transition between the microstrip and the waveguide. A useful prior art transition is shown in International application WO 98/11621 where a direct transition between the microstrip and the waveguide is provided by means of a ridge arranged in the waveguide, also called ridge waveguide. The end of the ridge, located at a transition end of the waveguide, is arranged in engagement with the microstrip, i.e. it is in contact with the top surface of the microstrip. The height of the ridge is gradually, i.e. stepwise or continuously, decreased in direction away from the transition end, during a transformation into a rectangular waveguide. This is an efficient way of transferring the signal from the microstrip to the waveguide, and of course the same arrangement is useful for receiving a signal as well, which is transferred from the waveguide to the microstrip.

[0003] Unfortunately, such a transition is sensitive as regards the mutual position of the ridge and the microstrip. For instance, only a minor lateral displacement causes a large attenuation of the signal due to mismatch of the characteristic impedances of the ridge and the microstrip, respectively, at the transition. As an example, at a signal frequency of 60 GHz, the relative reflected power, or return loss, at a lateral displacement of about 0.5% of the wavelength, i.e. about 0.025 mm, is about 20 dB, which is a limit of acceptance.

SUMMARY OF THE INVENTION

[0004] It is an object of the present invention to provide a transition between a microstrip and a waveguide that is less sensitive to mounting accuracy.

[0005] This object is achieved by a transition between a microstrip and a waveguide according to the present invention as defined in claim 1.

[0006] Thus, in accordance with an aspect of the present invention, there is provided a transition between a microstrip and a waveguide, comprising a rectangular waveguide having a floor, side walls, a ceiling, and a transition end; a microstrip; and a substrate integrated waveguide. At the transition end thereof, the rectangular waveguide is coupled to the substrate integrated waveguide at a first end of the substrate integrated waveguide. The microstrip is coupled to the substrate integrated waveguide at a second end thereof. The rectangular waveguide comprises a ridge attached to the ceiling, extending along a portion of the rectangular waveguide, and having a first end portion which is engaged with a portion of a top layer of the substrate integrated waveguide at its first end.

[0007] It has been discovered that it is possible to employ the substrate integrated waveguide (SIW) as an intermediate portion of the transition between the microstrip and the waveguide. Measurements as well as simulations have revealed that the transition between the SIW and the waveguide is substantially less sensitive to position displacements, lateral as well as longitudinal, between the ridge of the waveguide and the SIW. As an example, at a signal frequency of 60 GHz, like in the above example, the displacement causing the same relative reflected power, i.e. 20 dB, is 5% of the wavelength, which is 10 times as high tolerance as in the prior art transition between the mircrostrip and the waveguide. More particularly, 5% at 60 GHz corresponds to about 0.25 mm, which is a low accuracy in the present field of technology. This higher tolerance considerably simplifies the mounting operation and reduces costs involved. It should be noted that the frequency range for application of the invention is by no means limited to a narrow range, it is useful for the whole range of radio frequency communication, which is currently regarded to be from about 30 kHz to about 300 GHz.

[0008] In accordance with an embodiment of the transition, the characteristic impedance of the waveguide and the characteristic impedance of the substrate integrated waveguide are matched to each other, which provides for a maximum transfer of power from one to the other.

[0009] In accordance with an embodiment of the transition, at least an area of the substrate integrated waveguide extending between the transition end of the waveguide and the microstrip is covered by a solid metallic enclosure. Thereby this part of the transition is properly screened from spurious external signals, and the environment is protected from signals radiated from the circuitry within the enclosure.

[0010] In accordance with an embodiment of the transition, at the transition end of the waveguide, the floor and a portion of each side wall close to the floor end at the edge of the first end of the circuit board, the floor being coplanar with a bottom surface thereof, while the rest of the waveguide extends along a portion of a top surface of the circuit board. This is one advantageous way of aligning the floor of the waveguide with the ground plane of the SIW in order to facilitate the propagation of the electric field through the SIW to continue into the waveguide.

[0011] In accordance with an embodiment of the transition, the substrate integrated waveguide is included in a circuit board at a first end thereof. The circuit board comprises a substrate, wherein an end portion of the circuit board, at the first end thereof, comprises an uncovered portion of the substrate, and wherein a portion of the ridge adjacent to its end portion extends along the uncovered portion of the substrate. Thereby a smooth transition is achieved.

[0012] In accordance with an embodiment of the transition, the circuit board has a narrowed end portion at its first end, which narrowed end portion extends into the waveguide. This is another advantageous way of aligning the floor of the waveguide with the ground plane of the SIW in order to facilitate for the propagation of the electric field through the SIW to continue into the waveguide.

[0013] In accordance with an embodiment, the transition comprises a solid metal housing having two halves, wherein a bottom part of the waveguide is formed in a first half of the housing and a top part of the waveguide, including the ridge, is formed in a second half of the housing, and wherein at least the first half of the housing comprises a first seat in which a circuit board including the substrate integrated waveguide and the microstrip is arranged. This embodiment is advantageous in that the housing simplifies assembly.

[0014] In accordance with an embodiment of the transition, the first half of the housing comprises a wall section, which is arranged at the transition end of the rectangular waveguide, and which is in engagement with the substrate integrated waveguide and extends transverse thereof. Thereby the waveguide is separated from the SIW and mictrostrip and it is possible to form a tight enclosure enclosing the SIW and mictrostrip.

[0015] These and other aspects, features, and advantages of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The invention will now be described in more detail and with reference to the appended drawings in which:

Fig. 1 is a schematic partly cut way view in perspective of an embodiment of the transition according to the present invention;

Figs. 2a and 2b are schematic perspective views of top and bottom parts of the transition of Fig. 1;

Figs. 3a to 3e are schematic cross-sectional views taken at different portions of the transition as partly illustrated in Fig. 4;

Fig. 4 is a schematic perspective view of an opened up transition;

Fig. 5a is a schematic perspective view of the SIW according to an embodiment of the transition;

Fig. 5b is a schematic cross-sectional view of the transition of Fig. 5a;

Fig. 6a is a schematic perspective view of the SIW according to another embodiment of the transition;

Fig 6b is a schematic cross-sectional view of the transition of Fig. 6a; and

Fig. 7 is a schematic cross-sectional view of a SIW according to another embodiment of the transition.

DESCRIPTION OF PREFERRED EMBODIMENTS

[0017] Referring to Fig. 1, a part of a first embodiment of the transition according to this invention is shown. The transition 100 comprises a rectangular waveguide 102 having a floor 104, side walls 106, and a ceiling 108, a microstrip 110, and a substrate integrated waveguide 112. The waveguide 102 is arranged in engagement with the substrate integrated waveguide, or SIW, 112, at a transition end 114 of the waveguide 102. The waveguide 102 extends over a portion of the SIW 112 including a first end 116 thereof. The microstrip 110 is coupled to the SIW 112 at a second end thereof, wherein there is a continuous transition from the top layer of the microstrip 110 to the top layer of the SIW 112. The rectangular waveguide 102 comprises a ridge 118 attached to the ceiling 108, extending along a portion of the rectangular waveguide 102, and having a first end portion 120 which is engaged with a portion of the top layer 122 of the SIW at its first end 116. In Fig. 1 the waveguide 102 is partly cut away at the transition end 114, in order to show the structure of the very transition between the SIW 112 and the waveguide 102. The actual extension of the side walls 106 of the waveguide 102 is indicated by a broken line on the top layer 122 of the SIW 112. Additionally referring to e.g. Fig. 3b it is understood by a person skilled in the art that the SIW 310 is a kind of a waveguide having a layered structure of a ground plane 312, of a conductive material such as a metal, at the bottom of the structure, a substrate 314, of a dielectric material, in the middle, a top layer 316, of a conductive material such as a metal, and one or more rows of vias 318, which are through holes comprising a conductive material, typically an inside metal plating, connecting the top layer 316 with the ground plane 312. The vias 318 simulate the walls of a rectangular waveguide. Additionally referring to Fig. 3a, a microstrip, as understood by the skilled person, is a layer structure of a ground plane 304, a substrate 306, and a top layer 308, which parts have the similar characteristics as the corresponding parts of the SIW 310.

[0018] The SIW 112, and the microstrip 110 are arranged on a circuit board 124, only a portion of which is shown in Fig. 1, and which may comprise other circuits as well. According to this embodiment, the microstrip 110 includes different signal processing portions, for instance filters, amplifiers, mixers, switches and other active and passive circuits.

The SIW 112 comprises double rows of vias at its opposite longitudinal edges 126, 128. However, single or multiple rows of vias can be used. In order to obtain a stepwise transition from the SIW 112 to the ridge 118 facilitating the signal propagation past the transition, the top layer of the SIW 112 is removed at an end portion 130 of the SIW 112 at the first end 116 thereof, which is also a first end of the circuit board 124. Thereby a portion of the ridge 118 adjacent to its end portion 120 extends along the thus uncovered portion of the substrate 314. For the purposes of this application, the end portion 130 of the SIW 112 is still regarded as a part of the SIW although it is missing the top layer 122, since the rest of the SIW structure remain with via edges 126, 128, 318, ground plane 312 and substrate 314, and since, due to the ridge 118, the signal propagation is kept within the structure. The SIW 112 is broadened at the end portion 130, such that the walls 106 of the waveguide 102 extend just inside of the edges 126, 128 of the SIW 112, while at the adjacent portion of the SIW 112 where the ridge 118 engages the top layer 122 of the SIW 112 the side walls 106 of the waveguide 102 extends just outside of the edges 126, 128 of the SIW 112. This embodiment of the SIW 112 is more clearly shown in Figs. 5a and 5b, where the same reference numbers as above have been used for denoting the different parts and portions of the SIW 112. In large Fig. 5a shows a cut off portion of the circuit board 124, at a first end thereof, which includes the SIW 112. The position of the ridge 118 has been indicated with broken lines.

[0019] According to a second embodiment of the transition, the SIW 600, as shown in Figs. 6a and 6b, is not broadened at an end portion but it has straight via edges 602. Instead of ending the floor of the waveguide at the very end of the SIW, and having the side walls of the waveguide extending on top of the SIW, an end portion 604 of the circuit board 606 has been narrowed at a first end 607 thereof, to the width of the SIW 600. The end portion 604 extends into the waveguide 608 at the transition end thereof, where the ridge 610 is engaged with the top layer 612 of the SIW 600. A groove 614 has been formed in the floor 616 of the waveguide 608, and the ground plane 618 of the SIW 600 has been received in the groove 614.

[0020] The transition comprises a housing, which consists of two solid metal halves 200, 202, as shown in Figs. 2a and 2b. A bottom part 204 of the waveguide is formed as a bottom groove in a first half 200 of the housing, and a top part 206 of the waveguide, including the ridge 118, is formed in a second half 202 of the housing. The top part 206 of the waveguide includes a top groove 208 formed in the second half 202, the top groove 208 being defined by the ceiling 108, and by a major part of the side walls 106 mentioned above. The bottom part, or bottom groove, 204 of the waveguide is defined by the floor 104 and by minor parts of the side walls 106. The ridge 118 is formed as a ridge of material left in the middle of the top groove 208, and it has its full height at a transition portion 210 at the first end 212 thereof. The transition portion 210 includes the end portion and the portion adjacent thereto mentioned above, and it extends a distance towards a second opposite end 214 of the ridge 118. The height of the ridge 118 decreases, stepwise in this embodiment, to zero along a transformation portion 216 extending from the transition portion 210 to the second end 214. However, like in the prior art mentioned above, the decrease can be continuous, such as having a curved periphery, or any other kind of gradual transformation.

[0021] Furthermore, at least the first half 200 of the housing comprises a first seat 218 in which the circuit board 124 including the SIW 112 and the microstrip 110 has been received. The bottom groove 204 extends to the seat 218, and the first end 116 of the circuit board 124 is positioned adjacent to the end of the bottom groove 204.

[0022] The top groove 208 ends a bit ahead of the first end 212 of the ridge 118. That end of the top groove 208 constitutes the transition end 114 of the waveguide. A wall section 220 is arranged at the transition end 114, and it is followed by a large recess 222. When the two halves 200, 202 have been mounted together, the wall section 220 is in engagement with the SIW 112 and extends transverse thereof. Further, the recess 222 forms a space above the rest of the circuit board 124.

[0023] Referring to Figs. 3a to 3f, and Fig. 4, the signal propagation through the transition will be explained. For the purposes of exemplification, it is assumed that the signal is propagated from the microstrip to the waveguide. At the microstrip 302, comprising a ground plane 304, a substrate 306, and a top layer 308, and being enclosed by the walls defining the recess 222, the major part of the signal energy propagates through the substrate 306, as shown in Fig. 3a. The cross-section of Fig. 3a is taken along line A-A in Fig. 4.

[0024] The cross-section of Fig. 3b shows the SIW 310, which is also enclosed in the recess 222, and which comprises a ground plane 312, which is another portion of the same layer as used for the microstrip 302, a substrate 314, a top layer 316, and plated vias 318 connecting the top layer 316 with the ground plane 312. Here, the signal energy is kept within the substrate 314.

[0025] At the wall section 220, which is engaged with the top layer 316 of the SIW 310, nothing changes, the signal still propagates within the SIW 310. This is illustrated in Fig. 3c, which is a cross-section taken along line B-B in Fig. 4.

[0026] Referring now to Fig. 3d, when the signal reaches the area where the ridge 118 is engaged with the top surface 316 of the SIW 310, the signal propagation through the SIW 310 remains the same.

[0027] In order to obtain a smooth transition from the

SIW 310 to the waveguide 102, at a next portion of the transition, the top layer 316 of the SIW 310 has been removed, uncovering the substrate 314. The ridge 118 takes the role of the top layer, and the signal can continue to propagate through the substrate 314. See Fig. 3e, which is a cross-section along line C-C in Fig. 4.

[0028] At the end of the circuit board 124, the ground plane 310 is aligned with the floor 104 of the waveguide 102, and it is possible for the signal to continue from the end of the SIW 310, 112 and the circuit board 124 into the gap between the ridge 118 and the floor 104, as shown in Fig. 3f. By means of the conventional transformation of the ridge waveguide to the rectangular waveguide, the transition is completed.

[0029] According to another embodiment of the transition, a part of which is shown in Fig. 7, the ground plane of the SIW 700 is not integrated in the circuit board. Instead, the ground plane 702 is integrated in the first half of the housing. More particularly, the circuit board part of the SIW 700 comprises a substrate 704, a top layer 706, and vias 708, while the ground plane 702 is provided by the housing, i.e. the metal of the housing located beneath the substrate 704 constitutes the ground plane 702. The substrate 704 is arranged in engagement with the ground plane 702, and it is preferably rigidly attached to the ground plane 702 by means of soldering, adhesive bonding, or the like. As an alternative to the shown planar top surface of the ground plane, the SIW 700 can be received in a recess of the housing as in the above embodiments. The housing still provides the ground plane.

[0030] Above, embodiments of the transition according to the present invention as defined in the appended claims have been described. These should be seen as merely non-limiting examples. As understood by a skilled person, many modifications and alternative embodiments are possible within the scope of the invention.

[0031] It is to be noted, that for the purposes of this application, and in particular with regard to the appended claims, the word "comprising" does not exclude other elements or steps, that the word "a" or "an", does not exclude a plurality, which per se will be apparent to a person skilled in the art.

Claims

1. A transition between a microstrip and a waveguide, comprising:

   - a rectangular waveguide (102) having a floor (104), side walls (106), a ceiling (108), and a transition end;
   - a microstrip (110); and
   - a substrate integrated waveguide (112),

   wherein the rectangular waveguide (102), at the transition end thereof, is coupled to the substrate integrated waveguide (112) at a first end of the substrate integrated waveguide, wherein the microstrip (110) is coupled to the substrate integrated waveguide (112) at a second end thereof, and wherein the rectangular waveguide (102) comprises a ridge (118) attached to the ceiling (108), extending along a portion of the rectangular waveguide (102), and having a first end portion which is engaged with a portion of a top surface of the substrate integrated waveguide (112) at its first end.

2. A transition according to claim 1, wherein the characteristic impedance of the waveguide and the characteristic impedance of the substrate integrated waveguide are matched to each other.

3. A transition according to claim 1 or 2, wherein at least an area of the substrate integrated waveguide extending between the transition end of the waveguide and the microstrip is covered by a solid metallic enclosure.

4. A transition according to any one of the preceding claims, wherein the substrate integrated waveguide is included in a circuit board at a first end thereof.

5. A transition according to claim 4, wherein, at the transition end of the waveguide, the floor and a portion of each side wall close to the floor end at the edge of the first end of the circuit board, the floor being coplanar with a bottom surface thereof, while the rest of the waveguide extends along a portion of a top surface of the circuit board.

6. A transition according to claim 4 or 5, wherein the circuit board comprises a substrate, wherein an end portion of the circuit board, at the first end thereof, comprises an uncovered portion of the substrate, and wherein a portion of the ridge adjacent to its end portion extends along the uncovered portion of the substrate.

7. A transition according to claim 4, wherein the circuit board has a narrowed end portion at its first end, which narrowed end portion extends into the waveguide.

8. A transition according to any one of the preceding claims, comprising a solid metal housing having two halves, wherein a bottom part of the waveguide is formed in a first half of the housing and a top part of the waveguide, including the ridge, is formed in a second half of the housing, and wherein at least the first half of the housing comprises a first seat in which a circuit board including the substrate integrated waveguide and the microstrip is arranged.

9. A transition according to claim 8, wherein the second half of the housing comprises a wall section, which

is arranged at the transition end of the rectangular waveguide, and which is in engagement with the substrate integrated waveguide and extends transverse thereof.

10. A transition according to any one of claims 8 or 9, wherein the circuit board comprises a substrate and a top layer of the substrate integrated waveguide, and the housing comprises a ground plane of the substrate integrated waveguide, and wherein the substrate is in engagement with the ground plane.

Patentansprüche

1. Übergang zwischen einem Mikrostreifen und einem Wellenleiter, der Folgendes umfasst:

- einen rechteckigen Wellenleiter (102) mit einem Boden (104), Seitenwänden (106), einer Decke (108) und einem Übergangsende;
- einen Mikrostreifen (110); und
- einen Substrat-integrierten Wellenleiter (112),

wobei der rechteckige Wellenleiter (102) an seinem Übergangsende mit dem Substrat-integrierten Wellenleiter (112) an einem ersten Ende des Substrat-integrierten Wellenleiters gekoppelt ist, wobei der Mikrostreifen (110) mit dem Substrat-integrierten Wellenleiter (112) an seinem zweiten Ende gekoppelt ist, und wobei der rechteckige Wellenleiter (102) eine Erhöhung (118) umfasst, die an der Decke (108) angebracht ist und sich entlang eines Abschnitts des rechteckigen Wellenleiters (102) erstreckt, und einen ersten Endabschnitt aufweist, der mit einem Abschnitt einer Oberseite des Substrat-integrierten Wellenleiters (112) an seinem ersten Ende in Eingriff steht.

2. Übergang nach Anspruch 1, wobei die Kennimpedanz des Wellenleiters und die Kennimpedanz des Substrat-integrierten Wellenleiters aneinander angepasst sind.

3. Übergang nach Anspruch 1 oder 2, wobei mindestens ein Bereich des Substrat-integrierten Wellenleiters, der sich zwischen dem Übergangsende des Wellenleiters und dem Mikrostreifen erstreckt, von einem massiven metallischen Gehäuse bedeckt ist.

4. Übergang nach einem der vorangehenden Ansprüche, wobei der Substrat-integrierte Wellenleiter in einer Leiterplatte in einem ersten Ende enthalten ist.

5. Übergang nach Anspruch 4, wobei an dem Übergangsende des Wellenleiters, des Bodens und eines Abschnitts jeder Seitenwand nahe dem Bodenende am Rand des ersten Endes der Leiterplatte der Boden koplanar mit einer Unterseite verläuft, während sich des Rest des Wellenleiters entlang eines Abschnitts einer Oberseite der Leiterplatte erstreckt.

6. Übergang nach Anspruch 4 oder 5, wobei die Leiterplatte ein Substrat umfasst, wobei ein Endabschnitt der Leiterplatte an ihrem ersten Ende einen unbedeckten Abschnitt des Substrats umfasst, und wobei sich ein Abschnitt der Erhöhung neben seinem Endabschnitt entlang des unbedeckten Abschnitts des Substrats erstreckt.

7. Übergang nach Anspruch 4, wobei die Leiterplatte einen schmaleren Endabschnitt an ihrem ersten Ende aufweist, wobei sich der schmalere Endabschnitt in den Wellenleiter hinein erstreckt.

8. Übergang nach einem der vorangehenden Ansprüche, der ein massives Metallgehäuse umfasst, das zwei Hälften aufweist, wobei ein unterer Teil des Wellenleiters in einer ersten Hälfte des Gehäuses ausgebildet ist und ein oberer Teil des Wellenleiters, der die Erhöhung enthält, in einer zweiten Hälfte des Gehäuses ausgebildet ist, und wobei mindestens die erste Hälfte des Gehäuses einen ersten Sitz umfasst, in dem eine Leiterplatte, die den Substrat-integrierten Wellenleiter und den Mikrostreifen enthält, angeordnet ist.

9. Übergang nach Anspruch 8, wobei die zweite Hälfte des Gehäuses eine Wandsektion umfasst, die an dem Übergangsende des rechteckigen Wellenleiters angeordnet ist und die im Eingriff mit dem Substrat-integrierten Wellenleiter steht und sich quer davon erstreckt.

10. Übergang nach einem der Ansprüche 8 oder 9, wobei die Leiterplatte ein Substrat und eine Deckschicht des Substrat-integrierten Wellenleiters umfasst und das Gehäuse eine Grundebene des Substrat-integrierten Wellenleiters umfasst, und wobei das Substrat im Eingriff mit der Grundebene steht.

Revendications

1. Transition entre un microruban et un guide d'onde, comprenant :

- un guide d'onde rectangulaire (102) ayant un plancher (104), des parois latérales (106), un plafond (108) et une extrémité de transition ;
- un microruban (110) ; et
- un guide d'onde intégré au substrat (112) ;

dans laquelle le guide d'onde rectangulaire (102), à l'extrémité de transition de celui-ci, est couplé au guide d'onde intégré au substrat (112) à une première extrémité du guide d'onde intégré au substrat (112), dans laquelle le microruban (110) est couplé au guide d'onde intégré au substrat (112) à une deuxième extrémité de celui-ci, et dans laquelle le guide d'onde rectangulaire (102) comprend une arête (118) attachée au plafond (108), s'étendant le long d'une portion du guide d'onde rectangulaire (102), et ayant une première portion d'extrémité qui est mise en prise avec une portion d'une surface supérieure du guide d'onde intégré au substrat (112) à sa première extrémité.

2. Transition selon la revendication 1, dans laquelle l'impédance caractéristique du guide d'onde et l'impédance caractéristique du guide d'onde intégré au substrat correspondent l'une à l'autre.

3. Transition selon la revendication 1 ou 2, dans laquelle au moins une zone du guide d'onde intégré au substrat s'étendant entre l'extrémité de transition du guide d'onde et le microruban est recouverte d'une enceinte métallique solide.

4. Transition selon l'une quelconque des revendications précédentes, dans laquelle le guide d'onde intégré au substrat est inclus dans une carte de circuit à une première extrémité de celui-ci.

5. Transition selon la revendication 4, dans laquelle, à l'extrémité de transition du guide d'onde, le plancher et une portion de chaque paroi latérale proche du plancher se terminent au bord de la première extrémité de la carte de circuit, le plancher étant coplanaire avec une surface inférieure de celui-ci, alors que le reste du guide d'onde s'étend le long d'une portion d'une surface supérieure de la carte de circuit.

6. Transition selon la revendication 4 ou 5, dans laquelle la carte de circuit comprend un substrat, dans laquelle une portion d'extrémité de la carte de circuit, à la première extrémité de celle-ci, comprend une portion découverte du substrat, et dans laquelle une portion de l'arête adjacente à sa portion d'extrémité s'étend le long de la portion découverte du substrat.

7. Transition selon la revendication 4, dans laquelle la carte de circuit comprend une portion d'extrémité rétrécie à sa première extrémité, laquelle portion d'extrémité rétrécie s'étend dans le guide d'onde.

8. Transition selon l'une quelconque des revendications précédentes, comprenant un boîtier métallique solide comportant deux moitiés, dans laquelle une partie inférieure du guide d'onde est constituée dans une première moitié du boîtier et une partie supérieure du guide d'onde, comprenant l'arête, est constituée dans une deuxième moitié du boîtier, et dans laquelle au moins la première moitié du boîtier comprend un premier siège dans lequel une carte de circuit comprenant le guide d'onde intégré au substrat et le microruban est agencée.

9. Transition selon la revendication 8, dans laquelle la deuxième moitié du boîtier comprend une section de paroi, qui est agencée à l'extrémité de transition du guide d'onde rectangulaire, et qui est en prise avec le guide d'onde intégré au substrat et s'étend transversalement à celui-ci.

10. Transition selon l'une quelconque des revendications 8 et 9, dans laquelle la carte de circuit comprend un substrat et une couche supérieure du guide d'onde intégré au substrat, et le boîtier comprend un plan de masse du guide d'onde intégré au substrat, et dans laquelle le substrat est en prise avec le plan de masse.

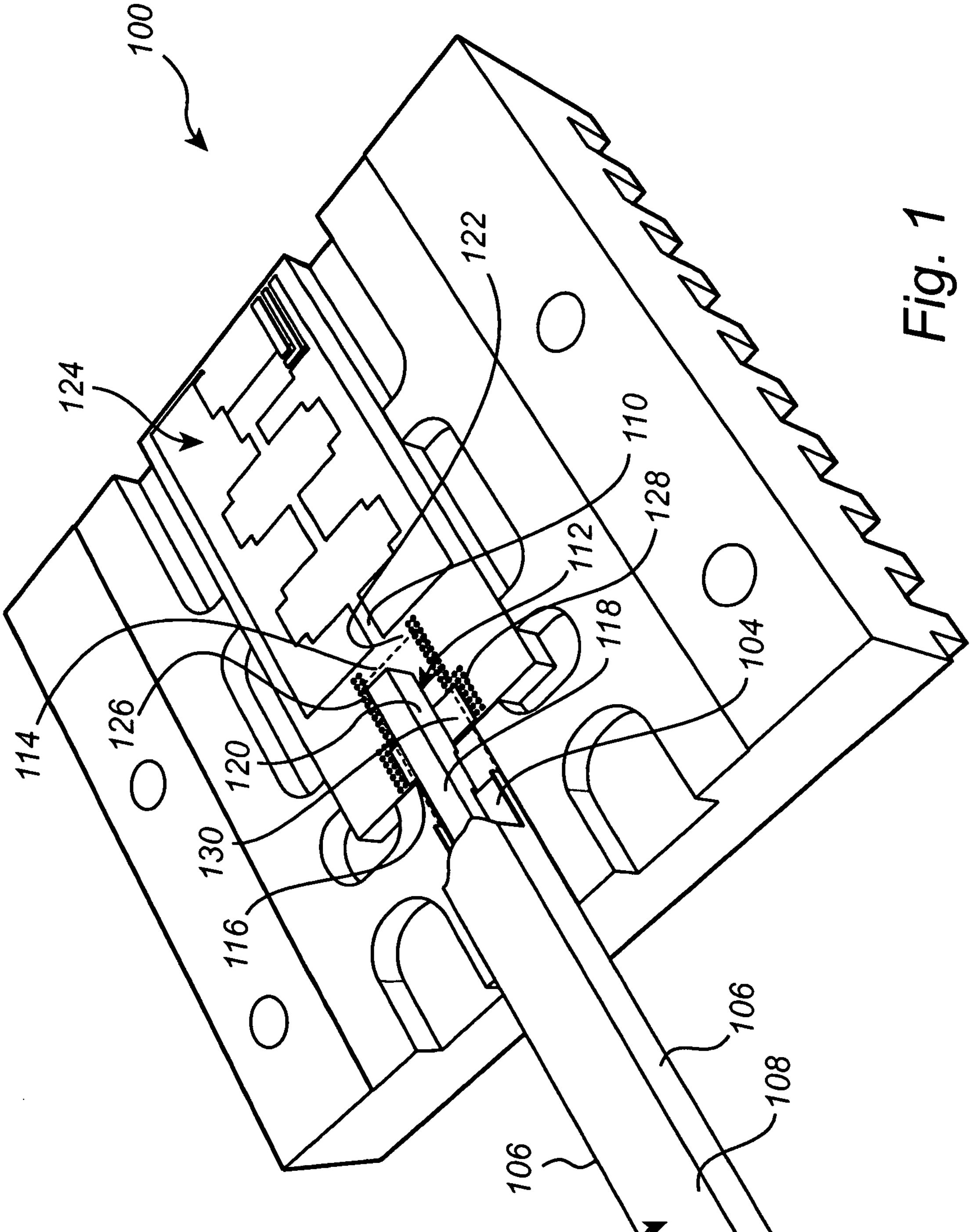
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Fig. 1

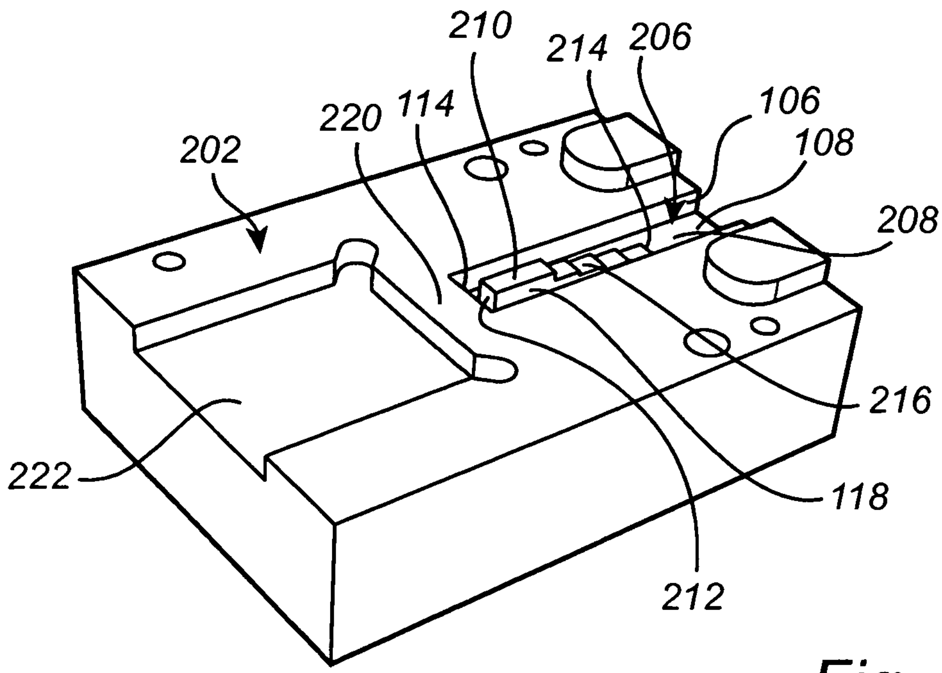
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Fig. 2a

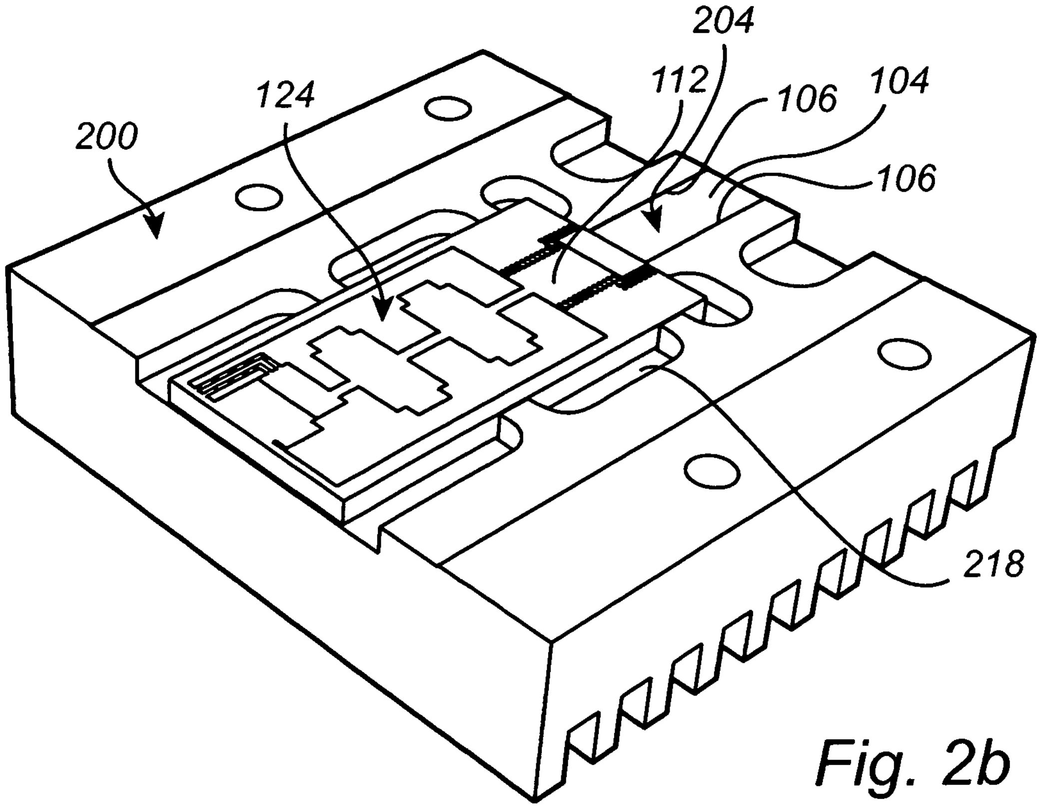
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Fig. 2b

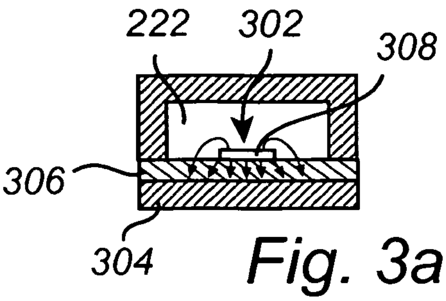

Fig. 3a

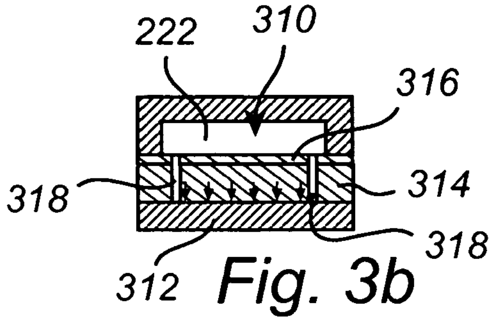

Fig. 3b

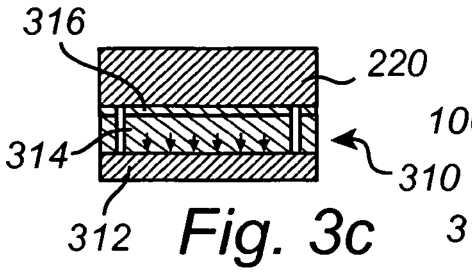

Fig. 3c

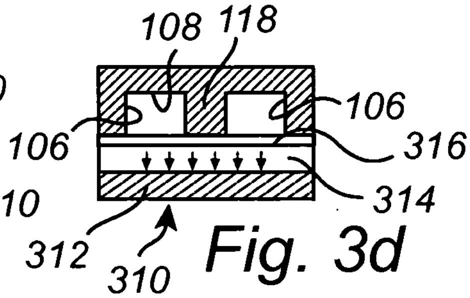

Fig. 3d

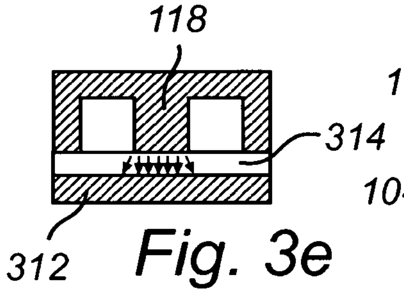

Fig. 3e

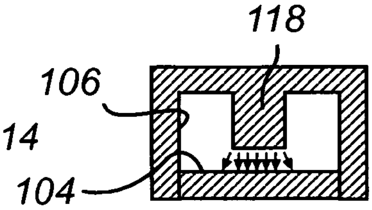

Fig. 3f

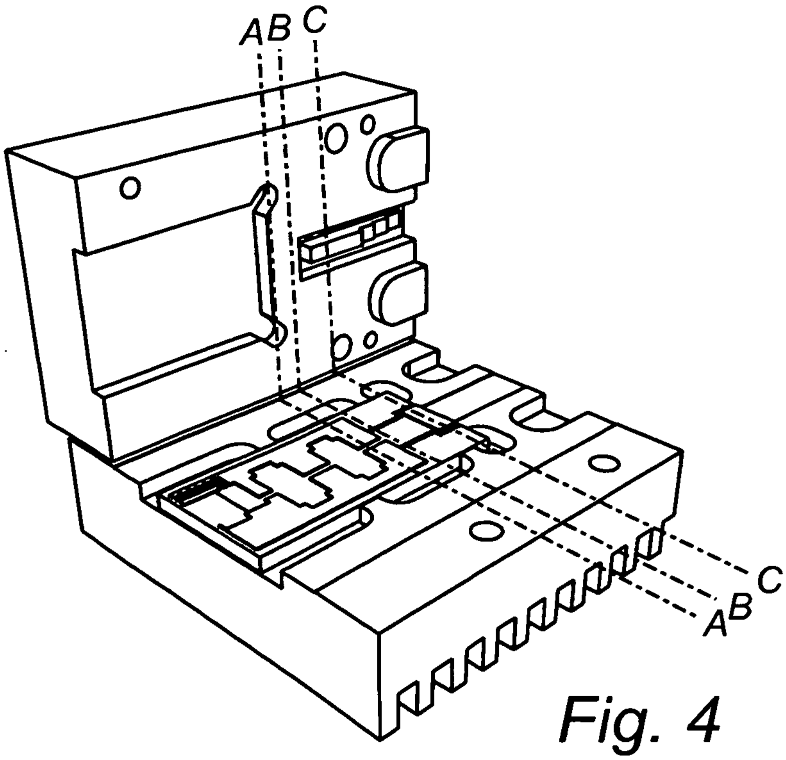

Fig. 4

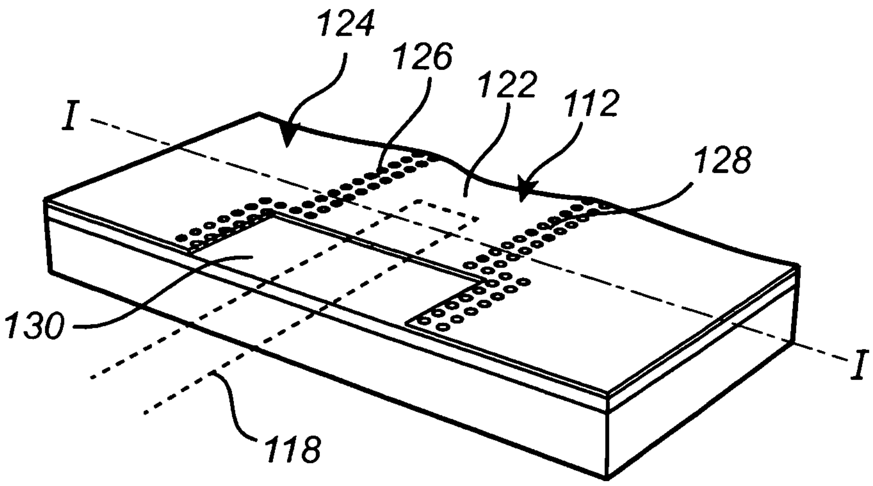

Fig. 5a

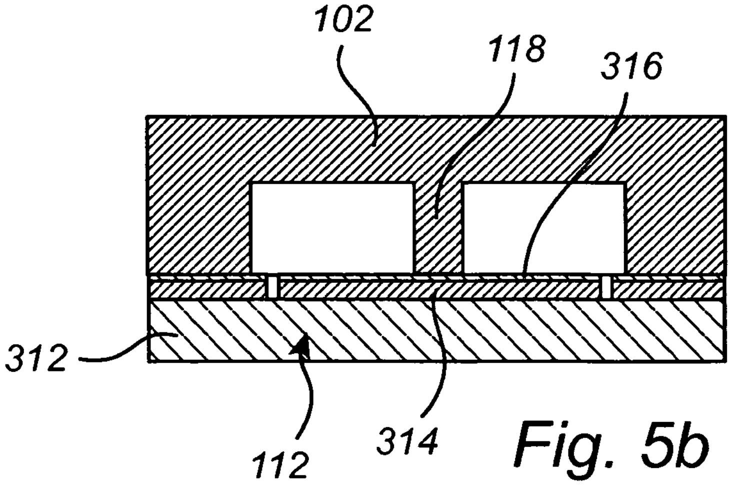

Fig. 5b

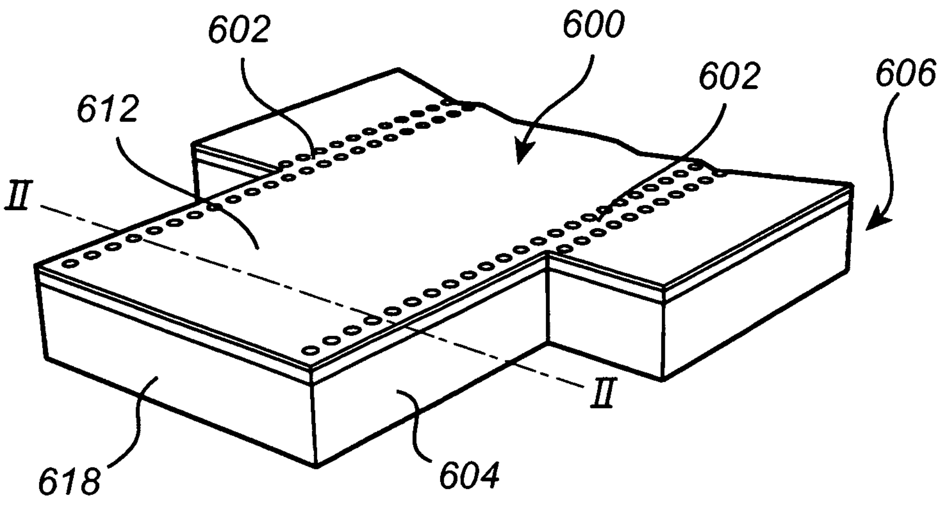

Fig. 6a

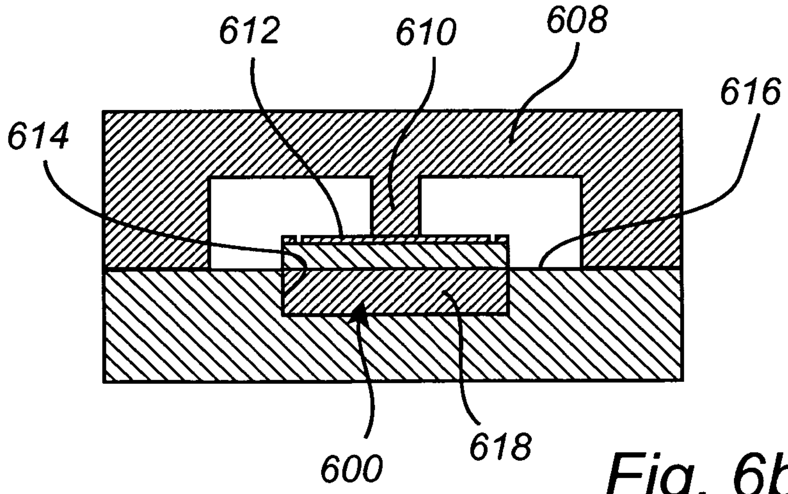

Fig. 6b

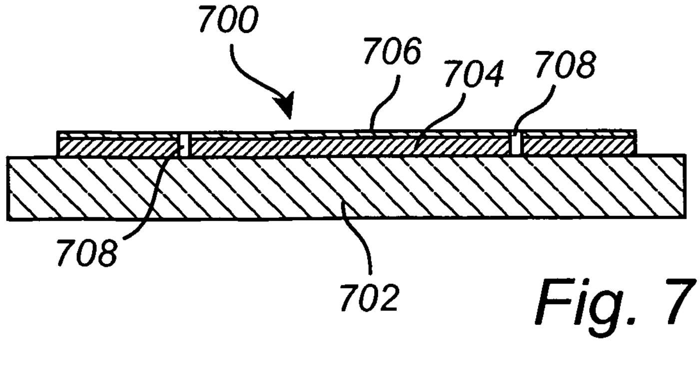

Fig. 7

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 9811621 A **[0002]**