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(72) Inventors:
• **Sato, Keiichiro**
Tokyo 145 (JP)
• **Saito, Shuji**
Tokyo 145 (JP)
• **Matsuzaki, Satoru**
Tokyo 145 (JP)

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(71) Applicant: **ALPS ELECTRIC CO., LTD.**
Ota-ku Tokyo 145 (JP)

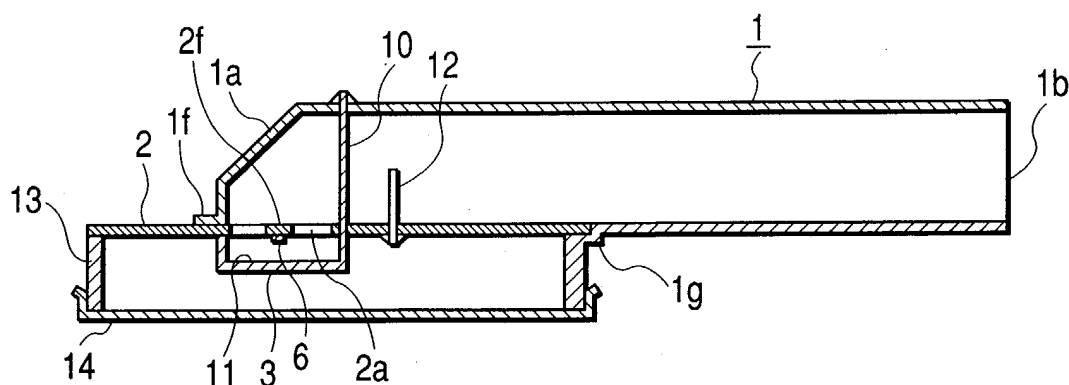
(74) Representative: **Kensett, John Hinton**
Saunders & Dolleymore,
9 Rickmansworth Road
Watford, Hertfordshire WD18 0JU (GB)

(54) **Converter for receiving satellite broadcast**

(57) A circuit substrate (2) is arranged in parallel with the tube axis of a waveguide (1) having an inclination face therein. A first probe (12) and a first short-circuited terminal (10) are inserted into this waveguide. A notch hole (2a) is formed in the circuit substrate. A second probe (6) is patterned and formed in a projecting piece extended toward the center of this notch hole. Matching patterns (4a, 8a) extended in the direction perpendicular to the projecting direction of the second

probe are formed outside the notch hole. Further, a second short-circuited terminal is formed on the inner bottom face of a cover body formed in a shape having a bottom. The matching patterns are faced and projected into the waveguide and the cover body by fixing this cover body to the waveguide through the notch hole of the circuit substrate. Thus, electricity supply efficiency of the second probe can be raised without arranging an impedance converting portion of a complicated shape within the waveguide.

FIG. 2



Description

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

[0001] The present invention relates to a converter for receiving a satellite broadcast which receives signals of two kinds of linearly polarized waves perpendicular to each other, and particularly relates to the converter for receiving the satellite broadcast in which a probe for detecting one of the linearly polarized waves is patterned and formed in a circuit substrate.

DESCRIPTION OF THE RELATED ART

[0002] Fig. 9 is a sectional view showing a conventional example of this kind of the converter for receiving the satellite broadcast. As shown in this figure, this converter for receiving the satellite broadcast has a waveguide 100 constructed by a metallic material of good electrical conductivity such as an aluminum die cast, a circuit substrate 101 forming a converter circuit, etc. therein, a cover body 102 formed in a shape having a bottom, etc.

[0003] An unillustrated horn portion is integrally formed on one end side of the waveguide 100, and an opening portion 100a is formed by opening the other end side downward in Fig. 9. An inclination face 100b opposed to the opening portion 100a is formed within the waveguide 100. This inclination face 100b crosses the tube axis of the waveguide 100 at an angle of about 45 degrees. Further, an impedance converting portion 100c is formed within the waveguide 100. This impedance converting portion 100c is formed in a stepwise shape so as to gradually reduce an opening area toward the inclination face 100b. The circuit substrate 101 is overlapped with the outer wall face of the waveguide 100, and a notch hole 101a opposed to the opening portion 100a of the waveguide 100 is formed in this circuit substrate 101. A projecting piece 101b extended toward the center of the notch hole 101a is formed. The cover body 102 covers the notch hole 101a of the circuit substrate 101 and the projecting piece 101b, and is fixed to the waveguide 100 by using plural screws 103.

[0004] A first probe 104 constructed by a pin member and a first short-circuited terminal 105 are inserted into the waveguide 100. This first probe 104 is soldered to an input section of the above converter circuit formed in the circuit substrate 101. The first short-circuited terminal 105 is arranged to reflect a first linearly polarized wave (e.g., a vertically polarized wave) advanced into the waveguide 100, and detect the first linearly polarized wave by the first probe 104. This first short-circuited terminal 105 is set in the position separated by about 1/4 wavelength in the advancing direction of a radio wave from the first probe 104. In contrast to this, a second probe 106 is patterned and formed in the projecting

piece 101b of the circuit substrate. This second probe 106 is connected to the input section of the above converter circuit. The inner bottom face of the above cover body 102 is set to a second short-circuited terminal 107 for reflecting a second linearly polarized wave (e.g., a horizontally polarized wave) advanced into the waveguide 100 and detecting this second linearly polarized wave by the second probe 106. This second short-circuited terminal 107 is set in the position separated by about 1/4 wavelength in the advancing direction of the radio wave from the second probe 106.

[0005] In the converter for receiving the satellite broadcast constructed in this way, when the radio wave transmitted from a satellite enters from the above horn portion and is advanced into the waveguide 100 as the first and second linearly polarized waves perpendicular to each other, the first linearly polarized wave is reflected in the first short-circuited terminal 105 and is detected by the first probe 104. Further, the second linearly polarized wave passes through the impedance converting portion 100c and is directionally converted on the inclination face 100b. Thereafter, the second linearly polarized wave is reflected in the second short-circuited terminal 107 of the cover body 102, and is detected by the second probe 106. The two orthogonal polarized wave signals detected by these first and second probes 104, 106 are frequency-converted to IF frequency signals by the above converter circuit formed in the circuit substrate 101, and are then outputted through an unillustrated output terminal.

[0006] In the above conventional converter for receiving the satellite broadcast, the stepwise impedance converting portion 100c for passing only the second linearly polarized wave is formed within the waveguide 100. Therefore, matching with the second probe 106 can be taken even when the electric field of the second linearly polarized wave is slightly disturbed by the influences of the first short-circuited terminal 105 and the inclination face 100b. Further, electricity supply efficiency of the second probe 106 can be raised by the impedance converting portion 100c. However, since such an impedance converting portion 100c must be formed within the waveguide 100, a problem exists in that the waveguide 100 is lengthened in the tube axis direction and is not easily made compact. Further, a problem exists in that the entire shape of the waveguide 100 becomes complicated and manufacture cost is raised.

SUMMARY OF THE INVENTION

[0007] The present invention is made in consideration of such a real situation of the prior art, and an object of the present invention is to provide a converter for receiving a satellite broadcast suitable for compactness and a reduction in cost.

[0008] To achieve the above object, the present invention resides in a converter for receiving a satellite broadcast and comprising a waveguide for advancing a

radio wave entering a waveguide tube as first and second linearly polarized waves perpendicular to each other, a first probe arranged so as to be projected into the tube of this waveguide, a first short-circuited terminal for reflecting said first linearly polarized wave and detecting this first linearly polarized wave by said first probe, a circuit substrate arranged at a rear portion opening end of said waveguide, a second probe patterned and formed in this circuit substrate and projected into the tube of said waveguide, and a second short-circuited terminal for reflecting said second linearly polarized wave and detecting this second linearly polarized wave by said second probe; wherein a ground conductor extended in the direction approximately perpendicular to the projecting direction of said second probe is patterned and formed in said circuit substrate, and is faced and projected into the tube of said waveguide.

[0009] In the converter for receiving the satellite broadcast constructed in this way, the ground conductor faced and projected into the tube of the waveguide becomes a capacity component, and electricity supply efficiency of the second probe can be raised by patterning and adjusting this ground conductor as a matching pattern. Therefore, it is not necessary to arrange an impedance converting portion of a complicated shape within the waveguide so that the waveguide can be correspondingly formed in a simple shape, and can be shortened in the tube axis direction.

[0010] In the above construction, it is sufficient to pattern and form the above ground conductor on at least one face of the circuit substrate. However, it is preferable to pattern and form the ground conductor on both the front and rear faces of the circuit substrate, and connect these ground conductors to each other through a through hole.

[0011] Further, in the above construction, the above circuit substrate can be arranged so as to be perpendicular to the tube axis of the waveguide. However, it is preferable to arrange the circuit substrate in parallel with the tube axis of the waveguide, and arrange an inclination face for guiding the second linearly polarized wave to the second short-circuited terminal within the waveguide. In this case, when the second short-circuited terminal is arranged on the inner bottom face of a cover body and this cover body is arranged oppositely to a rear portion opening end of the waveguide through the circuit substrate and is fixed to the waveguide by the first short-circuited terminal, the first short-circuited terminal can be also used as a fixing means of the cover body. In this case, it is preferable to integrally form the first short-circuited terminal in the cover body and extend this first short-circuited terminal through the circuit substrate and the tube interior of the waveguide and solder the first short-circuited terminal to the outer wall face of the waveguide since an assembly work can be simplified.

[0012] Embodiments of the invention will now be described, by way of example only, with reference to the

accompanying drawings, in which:

Fig. 1 is a plan view of a converter for receiving a satellite broadcast in accordance with a first embodiment mode example of the present invention;

Fig. 2 is a sectional view along line II-II of Fig. 1;

Fig. 3 is a perspective view of a waveguide arranged in the converter for receiving the satellite broadcast;

Fig. 4 is a perspective view of the waveguide seen from the side opposed to Fig. 3;

Fig. 5 is a plan view of a circuit substrate arranged in the converter for receiving the satellite broadcast;

Fig. 6 is a rear view of the circuit substrate;

Fig. 7 is a perspective view of a cover body arranged in the converter for receiving the satellite broadcast;

Fig. 8 is a sectional view of a main portion of a converter for receiving the satellite broadcast in accordance with a second embodiment mode example of the present invention.; and

Fig. 9 is a sectional view of a converter for receiving the satellite broadcast in a conventional example.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0013] The embodiment modes of the invention will next be explained with reference to the drawings. Fig. 1 is a plan view of a converter for receiving a satellite broadcast in accordance with a first embodiment mode example. Fig. 2 is a sectional view along line II-II of Fig. 1. Fig. 3 is a perspective view of a waveguide arranged in the converter for receiving the satellite broadcast. Fig. 4 is a perspective view of the waveguide seen from the side opposed to Fig. 3. Fig. 5 is a plan view of a circuit substrate arranged in the converter for receiving the satellite broadcast. Fig. 6 is a rear view of the circuit substrate. Fig. 7 is a perspective view of a cover body arranged in the converter for receiving the satellite broadcast.

[0014] The converter for receiving the satellite broadcast in accordance with this embodiment mode example has a waveguide 1 having an inclination face 1a on one end side thereof and formed in a square sleeve shape, and a circuit substrate 2 forming a converter circuit, etc. therein, a cover body 3 formed in a shape having a bottom, etc.

[0015] The waveguide 1 is constructed by bending and processing a metallic plate, and an end face on the side opposed to the inclination face 1a of this waveguide 1 is set to a front portion opening end 1b of a square shape. An unillustrated dielectric feeder is attached to this front portion opening end 1b. A radio wave transmitted from a satellite is guided from this dielectric feeder into the waveguide 1, and is then advanced toward the inclination face 1a as first and second linearly polarized waves perpendicular to each other. If a 90-degree

phase changing portion is arranged in this dielectric feeder, a circularly polarized wave transmitted from the satellite is converted to a linearly polarized wave, and can be guided into the waveguide 1. As shown in Figs. 3 and 4, a rectangular opening 1c is formed on one side face of the waveguide 1, and a hole 1d is formed on the other side face of the waveguide 1 opposed to this opening 1c. Plural leg pieces 1e, plural bending pieces 1f and one engaging piece 1g are formed on the periphery of the opening 1c. Each bending piece 1f is bent from the opening 1c toward the outside, but the engaging piece 1g is bent inside toward the opening 1c. The inclination face 1a crosses the tube axis of the waveguide 1 at an angle of about 45 degrees. The radio wave entering from the side of the front portion opening end 1b of the waveguide 1 is perpendicularly returned on the inclination face 1a, and is advanced in the direction of the opening 1c.

[0016] As shown in Figs. 5 and 6, a rectangular notch hole 2a, plural engaging holes 2b and positioning holes 2c, one through hole 2d and a look-through hole 2e are respectively formed in the circuit substrate 2. A projecting piece 2f extended toward the center of the notch hole 2a is formed on a long side of the notch hole 2a. An inside ground conductor 4 and an outside ground conductor 5 are patterned and formed on the surface of this circuit substrate 2. A portion extended along the opposed long side of the notch hole 2a in the inside ground conductor 4 functions as a matching pattern 4a described later. In contrast to this, a circuit element of an unillustrated converter circuit is mounted to the rear face of the circuit substrate 2. A second probe 6 connected to an input section of this converter circuit is patterned and formed on the projecting piece 2f. An outside ground conductor 7 is patterned and formed on the rear face of the circuit substrate 2 along its outer periphery. An inside ground conductor 8 is patterned and formed so as to surround the notch hole 2a. In this inside ground conductor 8, a portion extended along the opposed long side of the notch hole 2a functions as a matching pattern 8a described later. The matching patterns 4a, 8a on both the front and rear faces of the circuit substrate 2 are electrically conducted through many through holes 9.

[0017] As shown in Fig. 7, the cover body 3 is constructed by bending and processing a metallic plate in a square sleeve shape. Plural positioning projections 3a are integrally formed on an opposed side face of this cover body 3. Further, a first short-circuited terminal 10 projected in a band shape is integrally formed on one side face of the cover body 3. The inner bottom face of the cover body 3 is set to a second short-circuited terminal 11.

[0018] As shown in Figs. 1 and 2, the engaging piece 1g of the waveguide 1 is engaged with one side face of the circuit substrate 2, and each bending piece 1f is soldered to the outside ground conductor 5 in a state in which each leg piece 1e is inserted into the corresponding engaging hole 2b. Thus, the waveguide 1 is placed

and fixed onto the circuit substrate 2 such that its opening 1c is overlapped with the inside ground conductor 4. Thus, the opening 1c of the waveguide 1 is covered with the circuit substrate 2 in a portion except for the notch hole 2a. A rear portion opening end of the waveguide 1 is formed by the opening 1c overlapped with this notch hole 2a. A first probe 12 constructed by a pin member is inserted into the look-through hole 2e from the rear face side of the circuit substrate 2, and is then inserted into the waveguide 1. This first probe 12 is soldered to the input section of the above converter circuit formed in the circuit substrate 2.

[0019] Further, each positioning projection 3a of the cover body 3 is inserted into the corresponding positioning hole 2c of the circuit substrate 2. The first short-circuited terminal 10 is inserted into the hole 1d from the through hole 2d and is soldered to the outside face of the waveguide 1 so that the cover body 3 is fixed to the rear face side of the circuit substrate 2. Thus, a rear portion opening end of the waveguide 1 and the notch hole 2a of the circuit substrate 2 are covered with the cover body 3. The first short-circuited terminal 10 is arranged within the waveguide 1 in the position separated by about 1/4 wavelength in the advancing direction of the radio wave from the first probe 12. The second short-circuited terminal 11 is arranged in the position separated by about 1/4 wavelength in the advancing direction of the radio wave from the second probe 6. This first short-circuited terminal 10 is arranged to reflect a first linearly polarized wave (e.g., a vertically polarized wave) advanced within the waveguide 1 and detect this first linearly polarized wave by the first probe 12. The second short-circuited terminal 11 is arranged to reflect a second linearly polarized wave (e.g., a horizontally polarized wave) and detect this second linearly polarized wave by the second probe 6. Further, a frame body 13 constructed by a metallic material is fixed to the rear face side of the circuit substrate 2. This frame body 13 is soldered to the outside ground conductor 7 on the rear face of the circuit substrate 2. The above converter circuit formed on the rear face of the circuit substrate 2 is electrically shielded by covering an opening of this frame body 13 with a cover 14.

[0020] In the converter for receiving the satellite broadcast constructed in this way, the radio wave transmitted from the satellite enters the interior of the waveguide 1 from an unillustrated feeder attached to the front portion opening end 1b. When this radio wave is advanced into the waveguide 1 as the first and second linearly polarized waves perpendicular to each other, the first linearly polarized wave is reflected in the first short-circuited terminal 10, and is detected by the first probe 12. Further, the second linearly polarized wave is directionally converted on the inclination face 1a of the waveguide 1, and is then reflected in the second short-circuited terminal 11 of the cover body 3, and is detected by the second probe 6 on the circuit substrate 2. Here, matching patterns 4a, 8a are formed on both the front

and rear faces of the circuit substrate 2 outside the notch hole 2a faced and projected to the interior of the cover body 3 and the waveguide 1. These matching patterns 4a, 8a are extended in the direction perpendicular to the projecting direction of the second probe 6. Therefore, a reactance component of the second probe 6 and capacity components of the matching patterns 4a, 8a are generated within the waveguide 1 and the cover body 3. Accordingly, matching with the second probe 6 can be taken by suitably setting a pattern shape including the widths and the lengths of the matching patterns 4a, 8a even when the electric field of the second linearly polarized wave is slightly disturbed by the influences of the first short-circuited terminal 10 and the inclination face 1a. Accordingly, electricity supply efficiency of the second probe 6 can be raised. These two orthogonal polarized wave signals detected by the first and second probes 12, 6 are frequency-converted to IF frequency signals by the above converter circuit formed in the circuit substrate 2, and are then outputted through an unillustrated output terminal.

[0021] In the above converter for receiving the satellite broadcast in accordance with the first embodiment mode example, the matching patterns 4a, 8a extended in the direction perpendicular to the projecting direction of the second probe 6 are formed outside the notch hole 2a of the circuit substrate 2, and are faced and projected into the waveguide 1 and the cover body 3. Accordingly, the electricity supply efficiency of the second probe 6 can be raised without arranging an impedance converting portion of a complicated shape within the waveguide 1. Accordingly, the waveguide 1 of a simple shape formed by bending and processing a metallic plate can be used so that manufacture cost of the waveguide 1 can be correspondingly reduced, and the size of the waveguide 1 can be shortened in the tube axis direction and the waveguide 1 can be made compact. Further, since the matching patterns 4a, 8a are formed on both the front and rear faces of the circuit substrate 2 and both the matching patterns 4a, 8a are conducted through a through hole 9, the degree of freedom of the pattern shapes of the matching patterns 4a, 8a is widened, and matching of the second linearly polarized wave and the second probe 6 can be simply taken. Further, the first short-circuited terminal 10 is integrally formed in the cover body 3, and is extended through the circuit substrate 2 and the tube interior of the waveguide 1 and is soldered to the outer wall face of the waveguide 1. Accordingly, the first short-circuited terminal 10 can be also used as a fixing means of the cover body 3, and an assembly work can be simplified.

[0022] Fig. 8 is a sectional view of a main portion of a converter for receiving the satellite broadcast in accordance with a second embodiment mode example. In Fig. 8, portions corresponding to those of Fig. 2 are designated by the same reference numerals. broadcast

[0023] The converter for receiving the satellite broadcast in accordance with this embodiment mode example

differs from that in the above first embodiment mode example in that each of a waveguide 20 and a cover body 21 is formed by a metallic material such as an aluminum die cast, and a first short-circuited terminal 22 is formed by a member separated from the cover body 21. The other constructions are fundamentally the same as the first embodiment mode example. Namely, the waveguide 20 has a front portion opening end 20a on one end side thereof, and a rear portion opening end 20b is formed on the other end side. An inclination face 20c opposed to the rear portion opening end 20b is formed within the waveguide 20. The circuit substrate 2 is constructed similarly to the first embodiment mode example, and the cover body 21 covers the rear portion opening end 20b of the waveguide 1 and the notch hole 2a of the circuit substrate 2, and is fixed to the waveguide 20 by using a first short-circuited terminal 22 and a screw 23.

[0024] In the converter for receiving the satellite broadcast in accordance with the second embodiment mode example constructed in this way, matching patterns 4a, 8a extended in the direction perpendicular to the projecting direction of the second probe 6 are formed outside the notch hole 2a of the circuit substrate 2. These matching patterns 4a, 8a are faced and projected into the waveguide 20 and the cover body 21. Accordingly, electricity supply efficiency of the second probe 6 can be raised without arranging an impedance converting portion of a complicated shape within the waveguide 20 so that the waveguide 20 can be correspondingly formed in a simple shape and its manufacture cost can be reduced. Further, the size of the waveguide 20 is shortened in the tube axis direction, and the waveguide 20 can be made compact.

[0025] Further, in the above first and second embodiment mode examples, the waveguides 1, 20 having the inclination faces 1a, 20c therein are used, and the converter for receiving the satellite broadcast and having the circuit substrate 2 arranged in parallel with the tube axis of each of such waveguides 1, 20 has been explained. However, the waveguide of a straight shape having no inclination face therein can be also used, and the present invention can be also applied to the converter for receiving the satellite broadcast and having the circuit substrate arranged perpendicularly to the tube axis of such a waveguide. the a.bove first and second embodiment

[0026] Further, in the above first and second embodiment mode examples, the explanation has been made with respect to the case in which the matching patterns 4a, 8a are formed on both the front and rear faces of the circuit substrate 2. However, one of the matching patterns 4a, 8a may be omitted.

[0027] The present invention is embodied in the modes explained above, and has effects described below.

[0028] The converter for receiving the satellite broadcast has a waveguide for advancing a radio wave en-

tering a waveguide tube as first and second linearly polarized waves perpendicular to each other, a first probe arranged so as to be projected into the tube of this waveguide, a first short-circuited terminal for reflecting the first linearly polarized wave and detecting this first linearly polarized wave by the first probe, a circuit substrate arranged at a rear portion opening end of the waveguide, a second probe patterned and formed in this circuit substrate and projected into the tube of the waveguide, and a second short-circuited terminal for reflecting the second linearly polarized wave and detecting this second linearly polarized wave by the second probe; wherein a ground conductor extended in the direction approximately perpendicular to the projecting direction of the second probe is patterned and formed in the circuit substrate, and is faced and projected into the tube of the waveguide. Accordingly, the ground conductor faced and projected into the tube of the waveguide becomes a capacity component, and electricity supply efficiency of the second probe can be raised by patterning and adjusting this ground conductor as a matching pattern. Therefore, it is not necessary to arrange an impedance converting portion of a complicated shape within the waveguide, and the waveguide can be formed in a simple shape, and can be shortened in the tube axis direction.

Claims

1. A converter for receiving a satellite broadcast comprising a waveguide for advancing a radio wave entering a waveguide tube as first and second linearly polarized waves perpendicular to each other, a first probe arranged so as to be projected into the tube of this waveguide, a first short-circuited terminal for reflecting said first linearly polarized wave and detecting this first linearly polarized wave by said first probe, a circuit substrate arranged at a rear portion opening end of said waveguide, a second probe patterned and formed in this circuit substrate and projected into the tube of said waveguide, and a second short-circuited terminal for reflecting said second linearly polarized wave and detecting this second linearly polarized wave by said second probe;

wherein a ground conductor extended in the direction approximately perpendicular to the projecting direction of said second probe is patterned and formed in said circuit substrate, and is faced and projected into the tube of said waveguide.
2. The converter for receiving the satellite broadcast according to claim 1, wherein said ground conductor is patterned and formed on both front and rear faces of said circuit substrate, and these ground conductors are connected to each other through a through hole.
3. The converter for receiving the satellite broadcast according to claim 1 or 2, wherein said circuit substrate is arranged in parallel with the tube axis of said waveguide, and an inclination face for guiding said second linearly polarized wave to said second short-circuited terminal is arranged in said waveguide.
4. The converter for receiving the satellite broadcast according to claim 3, wherein said second short-circuited terminal is arranged on the inner bottom face of a cover body, and this cover body is arranged oppositely to a rear portion opening end of said waveguide through said circuit substrate, and is fixed to said waveguide by said first short-circuited terminal.
5. The converter for receiving the satellite broadcast according to claim 4, wherein said first short-circuited terminal is integrally formed in said cover body, and is extended through said circuit substrate and the tube interior of said waveguide, and is soldered to the outer wall face of the waveguide.

FIG. 1

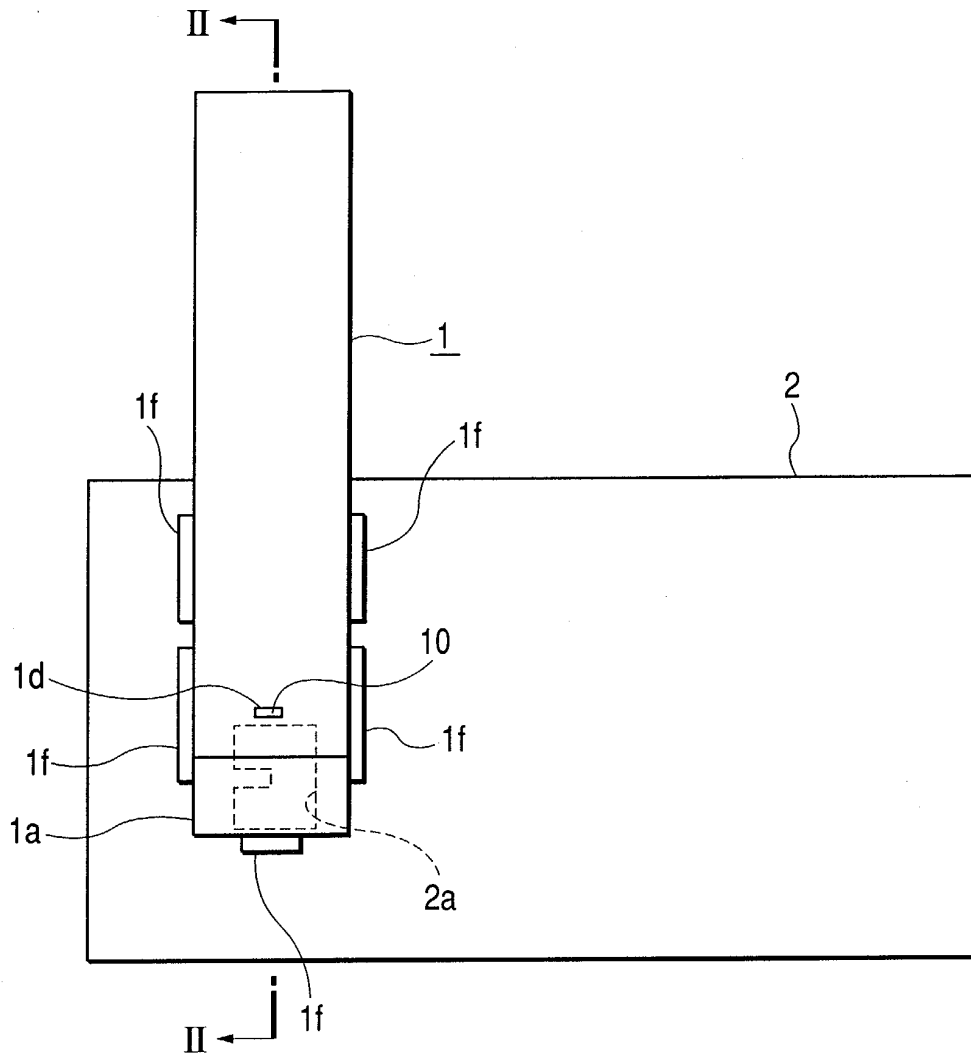


FIG. 2

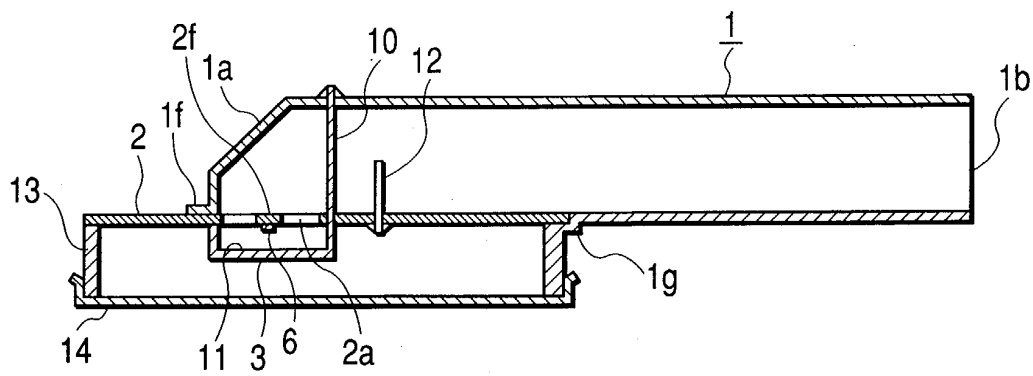


FIG. 3

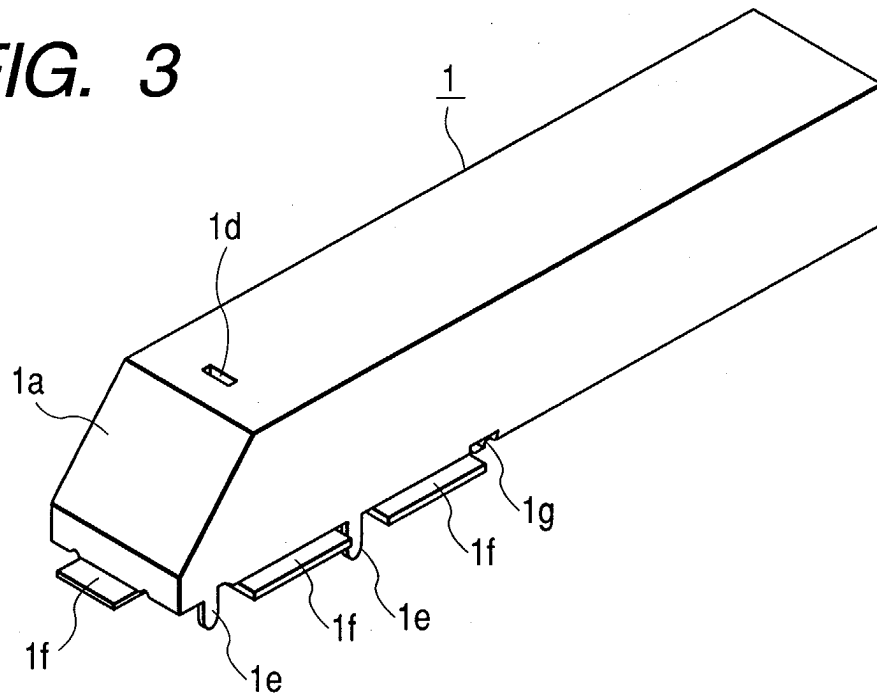


FIG. 4

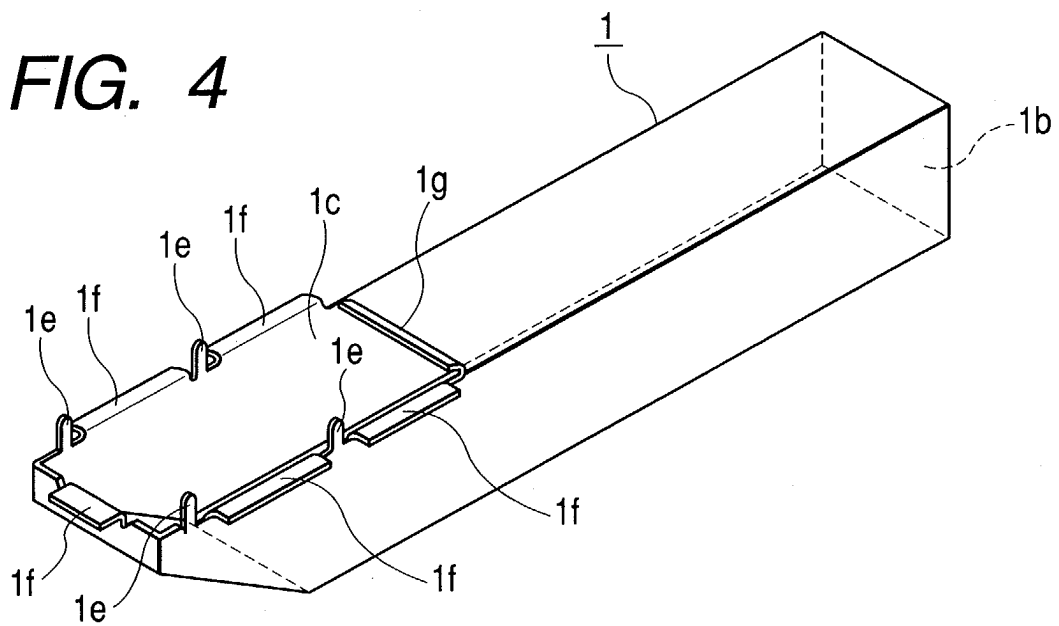


FIG. 5

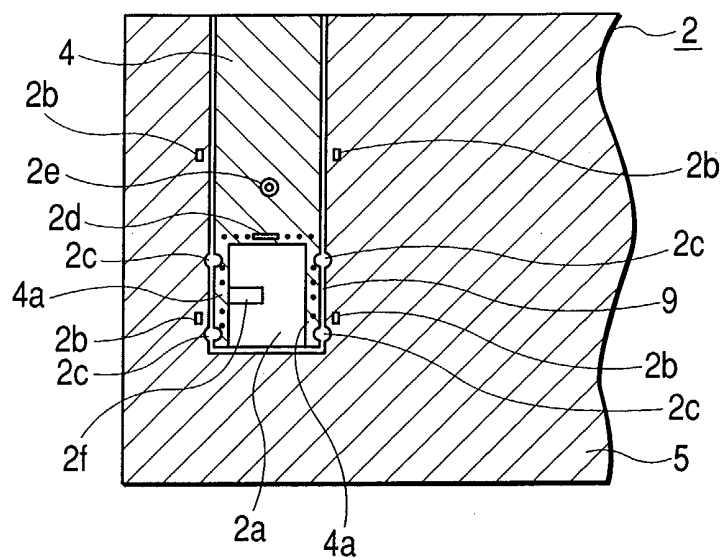


FIG. 6

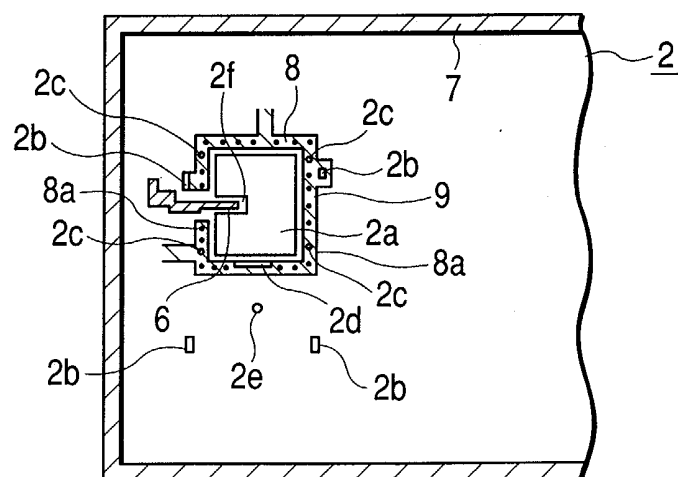


FIG. 7

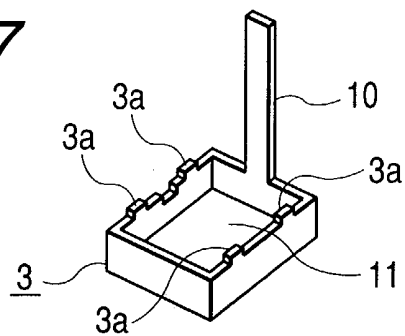


FIG. 8
PRIOR ART

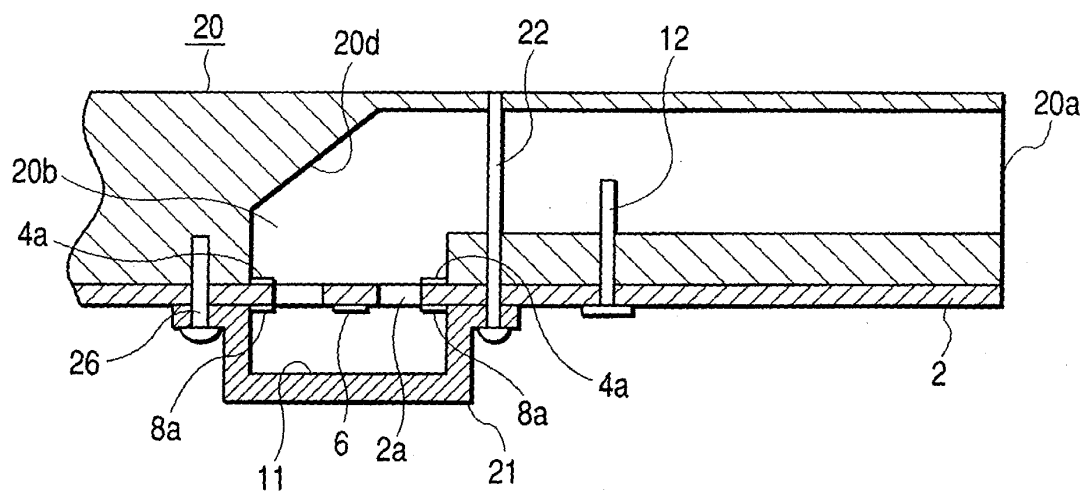
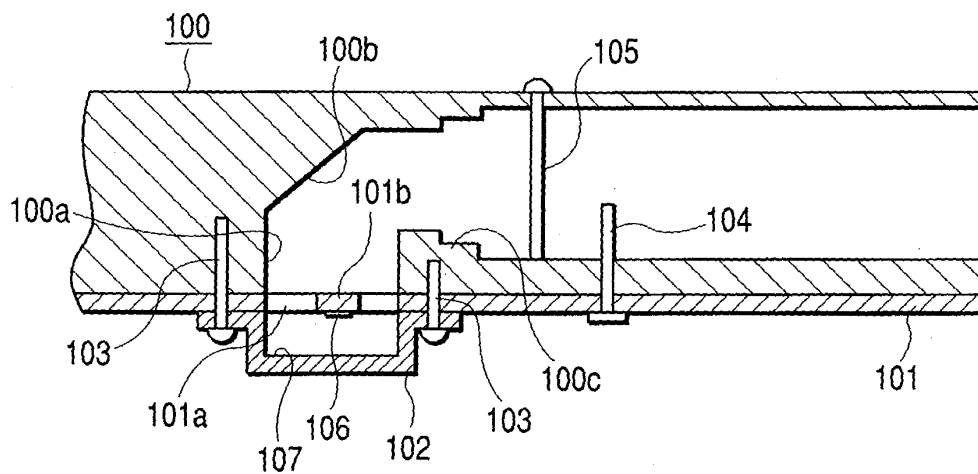


FIG. 9
PRIOR ART





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 03 25 4616

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The present search report has been drawn up for all claims			
Place of search MUNICH		Date of completion of the search 5 November 2003	Examiner Hirsch, S
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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 03 25 4616

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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