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(71) Applicant: **ALPS ELECTRIC CO., LTD.**
Tokyo 145-8501 (JP)

(72) Inventor: **Maruyama, Takashi**
Ota-ku Tokyo (JP)

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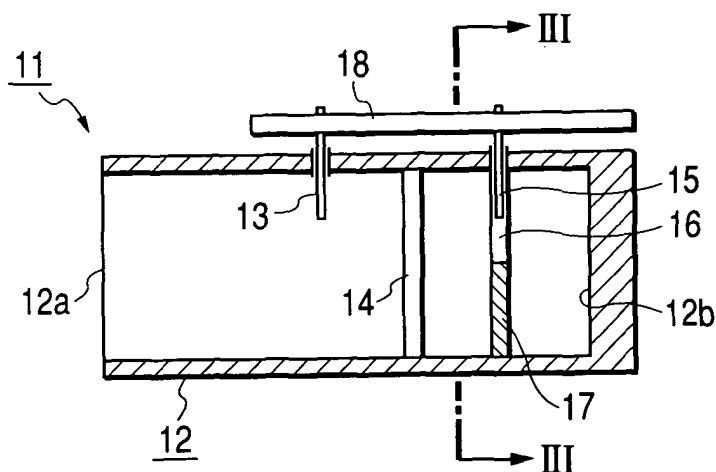
(74) Representative: **Klunker . Schmitt-Nilson . Hirsch**
Winzererstrasse 106
80797 München (DE)

(54) **Primary horn**

(57) A primary horn is adapted to attach two probes to a common circuit board to easily ensure a good receiving performance and reduce a manufacturing cost. The primary horn 11 includes a first probe 13 disposed at an open end 12a side of a waveguide 12 for detecting a first linearly polarized wave and a second probe 15 disposed at a termination short-circuit surface 12b side of the waveguide 12 for detecting a second linearly polarized wave orthogonal to the first linearly polarized wave. Both probes protrude parallel to each other. A re-

flector 14 for reflecting the first linearly polarized wave is interposed in the middle between both probes 13 and 15. A phase converter 17 forming a phase-adjusting aperture 16 is disposed in a plane comprising the second probe 15. Therefore, the second linearly polarized wave passes through the phase-adjusting aperture 16, so that the plane of polarization of the second linearly polarized wave is changed to be oriented in the same direction as the plane of polarization of the first linearly polarized wave.

FIG. 1



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a primary horn used in a converter for a satellite broadcasting reception, or the like, and more particularly, to a primary horn including first and second probes protruding in a waveguide for receiving two kinds of linearly polarized wave signals having a plane of polarization orthogonal to each other.

2. Description of the Related Art

[0002] Fig. 5 is a side sectional view of a primary horn widely known in the prior art, and Fig. 6 is a front view of the primary horn shown in Fig. 5. The known primary horn 1 includes a hollow waveguide 2 made of a metal material with good conductivity, a first probe 3 for receiving a first linearly polarized wave, a first circuit board 4 with the first probe 3 mounted thereto, a reflector 5 made of a metal plate for reflecting the first linearly polarized wave to make the first linearly polarized wave detected by the first probe 3, a second probe 6 for receiving a second linearly polarized wave having a plane of polarization orthogonal to the first linearly polarized wave, and a second circuit board 7 with the second probe 6 mounted thereto.

[0003] Although the waveguide 2 has an open end 2a at one end, it is closed by a termination short-circuit surface 2b at the other end. Signal waves entering the waveguide 2 from the open end 2a consist of a first linearly polarized wave and a second linearly polarized wave orthogonal to each other, and propagates toward the termination short-circuit surface 2b. The first probe 3, the reflector 5 and the second probe 6 are sequentially disposed from the open end 2a in the waveguide 2. The first probe 3 and the reflector 5 are disposed parallel to each other so that the probe overlaps the reflector when being viewed from the open end 2a side. However, the second probe 6 protrudes in the direction orthogonal to the first probe 3. In other words, the first probe 3 protrudes in the direction parallel to the plane of polarization of the first linearly polarized wave (for example, a vertically polarized wave), and the second probe 6 extends in the direction parallel to the plane of polarization of the second linearly polarized wave (for example, a horizontally polarized wave). In addition, the distance from the first probe 3 to the reflector 5 and the distance from the second probe 6 to the termination short-circuit surface 2b are set to about 1/4 of the free space wavelength λ of the signal wave to be received. Further, in the conventional horn, the waveguide 2 has a square cross section perpendicular to an axis direction of the waveguide 2, but it may be formed in a circular shape.

[0004] With the primary horn 1 configured in this way, it will now be described the operation of which the signal wave reaches the waveguide 2 from the open end 2a and propagates in the waveguide as the first linearly polarized wave and the second linearly polarized wave. The first linearly polarized wave is directly detected by the first probe 3 or is reflected by the reflector 5 and then is detected by the first probe 3. The detected signal is transmitted to the first circuit board 4. Since the first probe 3 protrudes in the direction orthogonal to the plane of polarization of the second linearly polarized wave, the second linearly polarized wave is not detected by the first probe 3. On the other hand, after the second linearly polarized wave bypasses the first probe 3 and the reflector 5, the second linearly polarized wave is directly detected by the second probe 6 or is reflected by the termination short-circuit surface 2b and then is detected by the second probe 6. Then, the detected signal is transmitted to the second circuit board 7. The first and second circuit boards 4, 7 are electrically connected to each other by a connecting means (not shown). The two kinds of orthogonal polarized wave signals, transmitted to the first and second circuit boards 4, 7, are transmitted to a converter circuit (not shown) attached to any one of circuit boards, and then the signals is converted into IF frequency signals. Then, the converted signals are outputted from the converter circuit.

[0005] Further, another conventional primary horn has been proposed, in which first and second probes protruding in the direction orthogonal to each other in the waveguide are attached to a common circuit board at an upright angle of 45°, respectively, thereby removing the connecting means by reducing the number of the circuit boards (for example, see Japanese Unexamined Patent Application Publication No. 9-312502 (Fig. 3 on Page 3)).

[0006] A further conventional primary horn has been proposed, in which any one of first and second probes is previously bent and the front ends of the first and second probes attached to the common circuit board are disposed in the direction orthogonal to each other in a waveguide (for example, see Japanese Unexamined Patent Application Publication No. 10-261902 (Fig. 1 on Pages 6 and 7)). In this case, it can remove the connecting means by reducing the number of the circuit boards.

[0007] According to the conventional primary horn 1 shown in Figs. 5 and 6, the first probe 3 and the second probe 6 are attached to the first circuit board 4 and the second circuit board 7, respectively, and then both circuit boards 4, 7 are electrically connected to receive two orthogonally polarized wave signals. Therefore, since two sheets of circuit boards are required, it is not easy to connect the circuit boards, and the circuit design is complicated.

[0008] According to the conventional primary horn disclosed in Japanese Unexamined Patent Application Publication No. 9-312502 (Fig. 3 on Page 3) or Japanese Unexamined Patent Application Publication No.

10-261902 (Fig. 1 on Pages 6 and 7), however, two probes (first probe and second probe) are attached to a common circuit board, so that there is an advantage that the number of the circuit boards are reduced to abbreviate the complicated process of connecting the circuit boards. However, with the primary horn disclosed in Patent Document 1, the prior art in which two probes are attached to the common circuit board at an upright angle of 45° , respectively, requires a high degree of precision for the attached portion. Therefore, there is a problem in that errors can occur in the positioning of the respective probes within the waveguide, thereby causing the receiving performance to be uneven. In order to ensure the desired receiving performance, a complicated adjusting operation is required, thereby easily increasing the manufacturing cost. Further, with the conventional primary horn disclosed in Patent Document 2, in which any one of the probes is previously bent to a desired shape, it is not easy to precisely perform the bending machining for the probe. Further, since a detected signal is easily reflected or interfered with by the bent portion of the probe, it also can cause the receiving performance to be uneven and increase the manufacturing cost.

SUMMARY OF THE INVENTION

[0009] In consideration of the above problem, it is an object of the present invention to provide a primary horn capable of attaching two probes to a common circuit board to easily ensure a good receiving performance and reduce manufacturing costs.

[0010] In order to achieve the above object, a primary horn according to the present invention includes a waveguide having an opening formed at one end and a termination short-circuit surface formed at the other end, in which signal waves entering the waveguide from the opening propagate as a first linearly polarized wave and a second linearly polarized wave orthogonal to each other; a first probe protruding in the direction parallel to the plane of polarization of the first linearly polarized wave within the waveguide for detecting first linearly polarized wave; a reflector disposed at the termination short-circuit surface side rather than the first probe within the waveguide for reflecting the first linearly polarized wave, thereby making the reflected first linearly polarized wave detected by the first probe; a metallic phase converter disposed at the termination short-circuit surface side rather than the reflector to form a locally narrow aperture within the waveguide, in which the aperture forms a phase-adjusting aperture for changing the direction of the plane of polarization of the second linearly polarized wave; a second probe protruding in the direction parallel to the first probe at a position of the termination short-circuit surface side rather than the reflector within the waveguide for detecting the second linearly polarized wave passing through the phase-adjusting aperture; and a circuit board mounted to the exterior of the waveguide in the direction parallel to the axis direction

of the waveguide, with the first and second probes being mounted to the circuit board, wherein the second linearly polarized wave passes through the phase-adjusting aperture, so that the plane of polarization of the second linearly polarized wave is changed to be oriented in the same direction as the plane of polarization of the first linearly polarized wave.

[0011] With the primary horn configured as described above, if the second linearly polarized wave passes through the phase-adjusting aperture formed by the phase converter in the waveguide, a phase difference of a given amount occurs between one orthogonal component and the other orthogonal component of the second linearly polarized wave. Therefore, the plane of polarization of the second linearly polarized wave combined with both orthogonal components causing the phase difference of an angle of 180° to be generated is changed in the direction orthogonal to the plane of polarization before the wave passes through the phase-adjusting aperture, that is, in the same direction as the plane of polarization of the first linearly polarized wave. Therefore, the second linearly polarized wave with the direction of the plane of polarization changed can be detected by the second probe protruding parallel to the first probe. These first and second probes can be easily and correctly attached to the common circuit board. As a result, since the positions of the first and second probes within the waveguide become uniform, a good receiving performance is easily ensured. Also, the complicated machining operation or installing operation is not required, thereby easily reducing the manufacturing cost.

[0012] In addition, the phase-adjusting aperture is a locally narrow opened portion formed in the waveguide by the phase converter. For example, in the shape of the phase-adjusting aperture, the aperture is sized so that the passage of the one orthogonal component of the second linearly polarized wave is not nearly influenced by the aperture, while the passage of the other orthogonal component is difficult due to the narrow aperture. As a result, immediately after the other orthogonal component passes through the phase-adjusting aperture, the wavelength thereof is increased in the waveguide. Therefore, the phase of the other orthogonal component progresses in proportion to the one orthogonal component.

[0013] In the construction as described the above, in the case of using only one phase converter, preferably, the phase converter is installed at a position where the distance from the vicinity of the second probe to the termination short-circuit surface is equal to the second probe, and the second linearly polarized wave passes through the phase-adjusting aperture formed by the phase converter, so that the direction of the plane of polarization of the second linearly polarized wave is distorted at an angle of about 180° . At that time, preferably, the distance from the phase converter to the termination short-circuit surface and the distance from the phase converter to the reflector are set to about $1/4$ of the free

space wavelength of the signal wave to be received, respectively. As one example of the phase converter capable of forming the phase-adjusting aperture by which the direction of the plane of polarization of the second linearly polarized wave is distorted at an angle of about 180° , in the case that the waveguide has a square cross section perpendicular to an axis direction, preferably, the phase converter is made of a metal plate of an isosceles right triangle, in which one side of the phase converter corresponding to a hypotenuse of the isosceles right triangle is positioned on a diagonal in the waveguide.

[0014] In addition, as another example of using two phase converters (a first phase converter and a second phase converter), preferably, the first phase converter is installed at a position where the distance from the vicinity of the second probe to the termination short-circuit surface is equal to the second probe, and the second linearly polarized wave passes through the phase-adjusting aperture formed by the first phase converter, so that the direction of the plane of polarization of the second linearly polarized wave is distorted at an angle of α° ($0 < \alpha < 180$) $^\circ$, and in which the second phase converter is installed at a position where the termination short-circuit surface is formed for the reflector and the open end is formed for the second probe, and the second linearly polarized wave passes through the phase-adjusting aperture formed by the second phase converter, so that the direction of the plane of polarization of the second linearly polarized wave is distorted by $(180-\alpha)^\circ$. At this time, preferably, the distance from the first phase converter to the termination short-circuit surface, the distance from the first phase converter to the second phase converter, and the distance from the second phase converter to the reflector are set to about 1/4 of the free space wavelength of the signal wave to be received, respectively.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015]

Fig. 1 is a side sectional view of a primary horn according to a first embodiment of the present invention;
 Fig. 2 is a front view of the primary horn shown in Fig. 1;
 Fig. 3 is a sectional view taken along a line III-III of Fig. 1;
 Fig. 4 is a side sectional view of a primary horn according to a second embodiment of the present invention;
 Fig. 5 is a side sectional view of a conventional primary horn; and
 Fig. 6 is a front view of the primary horn shown in Fig. 5.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0016] Hereinafter, embodiments of the present invention will be described with reference to the accompanying drawings. Fig. 1 is a side sectional view of a primary horn according to a first embodiment of the present invention. Fig. 2 is a front view of the primary horn. Fig. 3 is a sectional view taken along a line III-III in Fig. 1.

[0017] The primary horn 11 shown in the drawings includes a hollow waveguide 12 made of a metal material with good conductivity and molded through an aluminum die casting, a first probe 13 for receiving a first linearly polarized wave (for example, a vertical polarized wave), a reflector 14, formed of a metal plate and a metal rod, for reflecting the first linearly polarized wave to make the reflected first linearly polarized wave detected by the first probe 13, a second probe 15 for receiving a second linearly polarized wave (for example, a horizontally polarized wave) having a plane of polarization orthogonal to the first linearly polarized wave, a phase converter 17 formed of metal plate having a narrow aperture locally formed in the waveguide 12, the aperture used as a phase-adjusting aperture 16, and a circuit board 18 mounted to the exterior of the waveguide 12 and having the first and second probes 13 and 15 attached to it.

[0018] Although one end of the waveguide 12 forms an open end 12a, the other end of the waveguide is closed by a termination short-circuit surface 12b. Signal waves, entering the waveguide 12 from the open end 12a, consists of the first linearly polarized wave and the second linearly polarized wave orthogonal to each other, and propagates toward the termination short-circuit surface 12b. The waveguide 12 has a square cross section perpendicular to an axis direction thereof. The first probe 13 protrudes in the direction parallel to the plane of polarization of the first linearly polarized wave within the waveguide 12. The reflector 14 is disposed at a position overlapping the first probe 13 along the termination short-circuit surface 12b side or an axis direction of the waveguide 12 rather than the first probe 13 in the waveguide 12. The second probe 15 protrudes in the direction parallel to the first probe 13 at a position overlapping the first probe 13 along the termination short-circuit surface 12b side or an axis direction of the waveguide 12 rather than the reflector 14 in the waveguide 12. The phase converter 17 is a metal plate of an isosceles right triangle disposed at a plane comprising the second probe 15 within the waveguide 12, and is inserted such that half of the interior of the waveguide is closed at an angle in the direction orthogonal to the axis direction of the waveguide 12. Therefore, the remaining half of the interior of the waveguide which is not closed by the phase converter 17, i.e., the aperture, becomes the phase-adjusting aperture 16. Further, the second probe 15 is disposed in the phase-

adjusting aperture 16, so that the phase converter 17 and the second probe 15 have an equivalent distance to the termination short-circuit surface 12b. In addition, provided that a free space wavelength of a signal wave to be received is λ , the distance from the first probe 13 to the reflector 14, the distance from the phase converter 17 to the reflector 14 (that is, distance from the second probe 15 to the reflector 14), and the distance from the phase converter 17 to the termination short-circuit surface 12b (that is, distance from the second probe 15 to the termination short-circuit surface 12b) are set as about $\lambda/4$, respectively.

[0019] As shown in Fig. 3, the phase-adjusting aperture 16 formed by the phase converter 17 is a passage of an isosceles right triangle inclined at an angle of about 45° with respect to the plane of polarization of the second linearly polarized wave (left and right directions in Fig. 3). Provided that a length of hypotenuse is d , the height of the perpendicular bisector of the hypotenuse is $d/2$, thereby becoming a half of the hypotenuse. Further, as indicated by a vector in Fig. 3, if an electric field E of the second linearly polarized wave is decomposed into one orthogonal component E_1 along the hypotenuse of the phase-adjusting aperture 16 and the other orthogonal component E_2 orthogonal to the one orthogonal component E_1 , when the second linearly polarized wave passes through the phase-adjusting aperture 16, the phase-adjusting aperture 16 is sized so that the passage of the one orthogonal component E_1 is not nearly influenced by the aperture while the passage of the other orthogonal component E_2 is difficult due to the narrow aperture. As a result, immediately after passing through the phase-adjusting aperture 16, the other orthogonal component E_2 of the second linearly polarized wave propagates in a state largely inclined to the axis direction of the waveguide 12, thereby increasing the wavelength in the waveguide. However, although the orthogonal component E_1 along the hypotenuse of the phase-adjusting aperture 16 among the second linearly polarized waves passes through the phase-adjusting aperture 16, the wavelength thereof is not almost varied within the waveguide. Accordingly, the phase of the other orthogonal component E_2 transits with respect to the one orthogonal component E_1 . Specifically, a dimension of the phase-adjusting aperture 16 is so set that after the second linearly polarized wave passes through the phase-adjusting aperture 16 and is reflected to the termination short-circuit surface 12b, a phase difference of about 180° occurs between the one orthogonal component E_1 and the other orthogonal component E_2 at this point of time where the second linearly polarized wave is returned to the phase-adjusting aperture 16.

[0020] In the primary horn 11 configured in this way, it will now be described the operation of which the signal wave reaches the waveguide 12 from the open end 12a and propagates in the waveguide as the first linearly polarized wave and the second linearly polarized wave. If the first linearly polarized wave is referred to as the ver-

tically polarized wave and the second linearly polarized wave is referred to as the horizontally polarized wave, the vertically polarized wave entering the waveguide 12 from the open end 12a is directly detected by the first probe 13 or after being reflected by the reflector 14 is detected by the first probe 13. The detected signal is transmitted to a converter circuit (not shown) on the circuit board 18. Since the first probe 13 protrudes in the direction orthogonal to the plane of polarization of the horizontally polarized wave, the horizontally polarized wave is not detected by the first probe 13.

[0021] On the other hand, although the horizontally polarized wave entering the waveguide 12 from the open end 12a reaches the second probe 15, since the second probe 15 protrudes in the direction orthogonal to the plane of polarization of the horizontally polarized wave, at this time, the horizontally polarized wave is not detected by the second probe 15. In addition, after the horizontally polarized wave bypasses the second probe 15 and is reflected by the termination short-circuit surface 12b, it again reaches the second probe 15. However, the horizontally polarized wave should pass through the phase-adjusting aperture 16 when it bypasses the second probe 15. Accordingly, as described above, the phase difference of about 180° occurs between the one orthogonal component E_1 and the other orthogonal component E_2 in the horizontally polarized wave, at this point of time where the horizontally polarized wave reflected by the termination short-circuit surface 12b is returned to the second probe 15. As a result, the plane of polarization is altered as the same direction as the vertically polarized wave. In other words, after the horizontally polarized wave which is not detected by the second probe 15 passes through the phase-adjusting aperture 16, if the horizontally polarized wave is reflected by the termination short-circuit surface 12b and is returned to the second probe 15, the horizontally polarized wave is converted to the vertical polarized wave. As a result, the vertical polarized wave can be detected by the second probe 15. In addition, the detected signal is transmitted to the converter circuit of the circuit board 18.

[0022] The converter circuit of the circuit board 18 includes an amplifier for amplifying the detected signal transmitted from the first probe 13, an amplifier for amplifying the detected signal transmitted from the second probe 15, a mixer for frequency-converting the signal outputted from the respective amplifiers into an IF frequency signal, and an amplifier for amplifying the IF frequency signal. The two orthogonally polarized wave signals detected by the first and second probes 13, 15 are outputted from the converter circuit as the amplified IF frequency signal.

[0023] With the primary horn 11 according to this embodiment, if the second linearly polarized wave (for example, horizontally polarized wave) passes through the phase-adjusting aperture 16 formed in the waveguide 12 by the phase converter 17, the phase difference of

about 180° occurs between the one orthogonal component E_1 and the other orthogonal component E_2 in the second linearly polarized wave. Accordingly, the plane of polarization of the second linearly polarized wave formed by combining both orthogonal components E_1 and E_2 may be changed in the direction orthogonal to the plane of polarization before it passes through the phase-adjusting aperture 16, that is, in the same direction as the plane of polarization of the first linearly polarized wave (for example, the vertical polarized wave). As a result, the waveguide may adopt the structure of which the first probe 13 for receiving the first linearly polarized wave and the second probe 15 for receiving the second linearly polarized wave protrudes parallel to each other and which both probes 13 and 15 may be easily and correctly attached to the common circuit board 18. As a result, deviations of the positions of the first and second probes 13 and 15 are not generated in the waveguide 12, and a good receiving performance may be easily obtained. Further, the primary horn 11 of this embodiment does not require a complicated machining operation or attaching operation which are inevitable in the prior arts where two probes are attached to one circuit board, thereby easily reducing the manufacturing cost.

[0024] In the first embodiment, although it is described with reference to the case that the phase converter 17 has a triangle shape, the shape of the phase converter 17 is not limited thereto, and a rectangular shape or a frame shape may be employed. When the cross section of the waveguide 12 is square, it can be easily designed or manufactured, provided that one side corresponding to the hypotenuse of the phase converter 17 of the isosceles right triangle is positioned on a diagonal in the waveguide 12, as in the first embodiment. In addition, in the case that the cross-sectional shape of the waveguide 12 is a circle, it is preferred that the phase converter 17 have, for example, a semi-circular shape.

[0025] In addition, even if the installed position of the phase converter 17 is set in the middle between the reflector 14 and the second probe 15 along the axis direction of the waveguide 12, for example, when the distance from the phase converter 17 to the reflector 14 or the second probe 15, and the distance from the second probe 15 to the termination short-circuit surface 12b are set as about $\lambda/4$, it can expect the same effect as that of the first embodiment.

[0026] Fig. 4 is a side sectional view of a primary horn according to a second embodiment of the present invention, in which the same elements as that of Fig. 1 are denoted by the same reference numerals. In other words, the primary horn 20 shown in Fig. 4 employs two sheets of phase converters 21 and 22, the shape being almost identical to each other. The first phase converter 21 is positioned on a plane comprising the second probe 15 as in the first embodiment, while the second phase converter 22 is positioned in the middle between the reflector 14 and the second probe 15.

[0027] The first phase converter 21 forms a first phase-adjusting aperture 23 in the waveguide 12, and the second phase converter 22, positioned at the open end 12a thereof, forms a second phase-adjusting aperture 24 in the waveguide 12. The first and second phase-adjusting apertures 23 and 24 are apertures wider than the phase-adjusting aperture 16 of the first embodiment. Each of the phase-adjusting apertures 23 and 24 is set in such a manner that a phase difference of 90° may occur between the one orthogonal component and the other orthogonal component with respect to the second linearly polarized wave (for example, a horizontally polarized wave) entering the waveguide from the open end 12a and bypassing the first probe 13. In addition, provided that a free space wavelength of a signal wave to be received is λ in Fig. 4, the distance from the first phase converter 21 to the termination short-circuit surface 12b (that is, from the second probe 15 to the termination short-circuit surface 12b), the distance from the first phase converter 21 to the second phase converter 22 (that is, from the second probe 15 to the second phase converter 22), and the distance from the second phase converter 22 to the reflector 14 are set as about $\lambda/4$, respectively.

[0028] In the case of the primary horn 20, as in the first embodiment, the first and second probes 13 and 15 protrude in the direction parallel to each other. As a result, both probes 13 and 15 are easily and correctly attached to the common circuit board 18. Both probes 13 and 15 extend parallel to the plane of polarization of the first linearly polarized wave (for example, a vertically polarized wave), and the first linearly polarized wave entering the waveguide 12 from the open end 12a is detected by the first probe 13. Further, the second linearly polarized wave entering the waveguide from the open end 12a and bypassing the first probe 13 passes through the second phase-adjusting aperture 24. Then the second linearly polarized wave passes through the first phase-adjusting aperture 23 in which the second probe 15 is positioned, and is reflected by the termination short-circuit surface 12b to return to the second probe 15. In addition, when the second linearly polarized wave passes through the second phase-adjusting aperture 24, the direction of the plane of polarization is distorted at an angle of 90°. Then, when the second linearly polarized wave passes through the first phase-adjusting aperture 23, the direction of the plane of polarization is further distorted at an angle of 90°. As a result, at this point of time when the second linearly polarized wave is reflected by the termination short-circuit surface 12b to return to the second probe 15, the plane of polarization of the second linearly polarized wave is changed in the same direction as the plane of polarization of the first linearly polarized wave. Therefore, it is possible to detect the second linearly polarized wave by using the second probe 15. As this embodiment, since the radiator is adapted to change the direction of the plane of polarization through two steps by using the two sheets of

phase converters 21 and 22, so that there is another effect in that the bandwidth of the second linearly polarized wave is enlarged to obtain a proper receiving sensitivity, in addition to the effect of the first embodiment.

[0029] Further, in this embodiment, since the first and second phase converters 21 and 22 have almost identical shape, there is hardly a functional difference between the first phase-adjusting aperture 23 and the second phase-adjusting aperture 24, but the two sheets of the phase converters 21 and 22 may have a different shape. In that case, the phase converters 21 and 22 are disposed in such a manner that the second linearly polarized wave passes through the first phase-adjusting aperture 23 formed by the first phase converter 21 so that the direction of the plane of polarization of the second linearly polarized wave is distorted at an angle of α° ($0 < \alpha < 180$), and also, the second linearly polarized wave passes through the second phase-adjusting aperture 24 formed by the second phase converter 22 so that the direction of plane of polarization of the second linearly polarized wave is distorted at an angle of $(180-\alpha)^\circ$.

[0030] The present invention is carried out as the embodiments described above, and has the desired effects as follows.

[0031] Since the primary horn is configured in such a way that the first probe positioned at the open end of the waveguide for detecting the first linearly polarized wave and the second probe positioned at the termination short-circuit surface of the waveguide for detecting the second linearly polarized wave orthogonal to the first linearly polarized wave protrude parallel to each other and that the plane of polarization of the second linearly polarized wave is changed in the same direction as the plane of polarization of the first linearly polarized wave by passing through the phase-adjusting aperture formed by the phase converter, the first and second probe can be correctly and easily attached to the common circuit board. Further, deviations of the positions of the first and second probes are not generated in the waveguide, and a good receiving performance may be easily obtained. Further, the primary horn does not require a complicated machining or attaching operation, thereby easily reducing the manufacturing cost.

Claims

1. A primary horn comprising:

a waveguide having an opening formed at one end and a termination short-circuit surface formed at the other end, in which signal waves entering the waveguide from the opening propagate as a first linearly polarized wave and a second linearly polarized wave orthogonal to each other;
a first probe protruding in the direction parallel

to the plane of polarization of the first linearly polarized wave within the waveguide for detecting the first linearly polarized wave;

a reflector disposed at the termination short-circuit surface side rather than the first probe within the waveguide for reflecting the first linearly polarized wave, thereby making the reflected first linearly polarized wave detected by the first probe;

a metallic phase converter disposed at the termination short-circuit surface side rather than the reflector within the waveguide to form a locally narrow aperture within the waveguide, in which the aperture forms a phase-adjusting aperture for changing the direction of the plane of polarization of the second linearly polarized wave;

a second probe protruding in the direction parallel to the first probe at a position of the termination short-circuit surface side rather than the reflector within the waveguide for detecting the second linearly polarized wave passing through the phase-adjusting aperture; and
a circuit board mounted to the exterior of the waveguide in the direction parallel to an axis direction of the waveguide, the first and second probes being mounted to the circuit board,

wherein the second linearly polarized wave passes through the phase-adjusting aperture, so that the plane of polarization of the second linearly polarized wave is changed to be oriented in the same direction as the plane of polarization of the first linearly polarized wave.

2. The primary horn according to Claim 1,
wherein the phase converter is disposed at a position where the distance from the vicinity of the second probe to the termination short-circuit surface is equal to the second probe, and
wherein the second linearly polarized wave passes through the phase-adjusting aperture formed by the phase converter, so that the direction of the plane of polarization of the second linearly polarized wave is distorted at an angle of about 180° .
3. The primary horn according to Claim 2,
wherein the distance from the phase converter to the termination short-circuit surface and the distance from the phase converter to the reflector are set to about $1/4$ of the free space wavelength of the signal wave, respectively.
4. The primary horn according to any one of Claims 1 to 3,
wherein the waveguide has a square cross section perpendicular to an axis direction, and the

phase converter is made of a metal plate of an isosceles right triangle, in which one side of the phase converter corresponding to a hypotenuse of the isosceles right triangle is positioned on a diagonal in the waveguide.

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5. The primary horn according to any of Claims 1 to 4, wherein the phase converter includes a first phase converter and a second phase converter, in which the first phase converter is installed at a position where the distance from the vicinity of the second probe to the termination short-circuit surface is equal to the second probe, and the second linearly polarized wave passes through the phase-adjusting aperture formed by the first phase converter, so that the direction of the plane of polarization of the second linearly polarized wave is distorted at an angle of α° ($0 < \alpha < 180^\circ$), and in which the second phase converter is installed at a position where the termination short-circuit surface is formed for the reflector and the open end is formed for the second probe, and the second linearly polarized wave passes through the phase-adjusting aperture formed by the second phase converter, so that the direction of the plane of polarization of the second linearly polarized wave is distorted by $(180-\alpha)^\circ$.
6. The primary horn according to Claim 5, wherein the distance from the first phase converter to the termination short-circuit surface, the distance from the first phase converter to the second phase converter, and the distance from the second phase converter to the reflector are set to about $1/4$ of the free space wavelength of the signal wave, respectively.

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FIG. 1

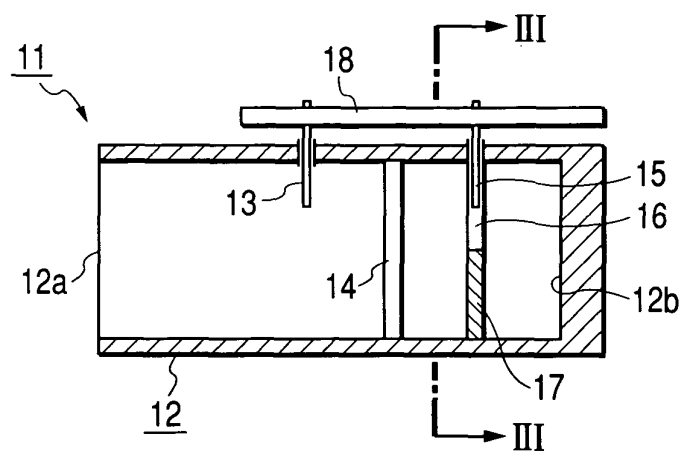


FIG. 2

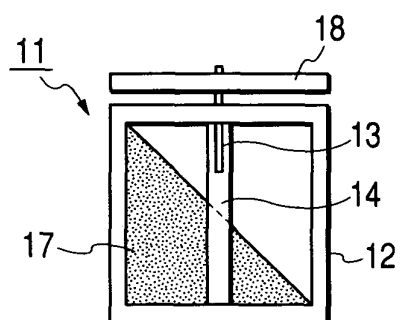


FIG. 3

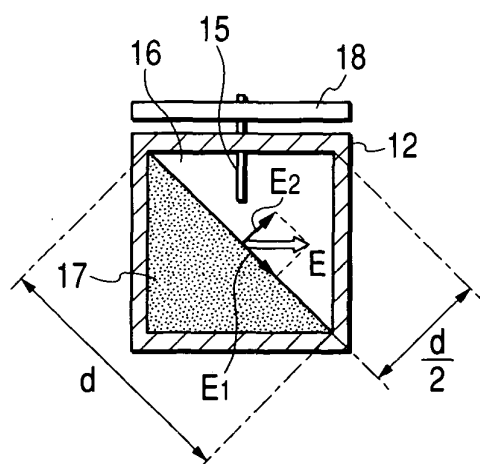


FIG. 4

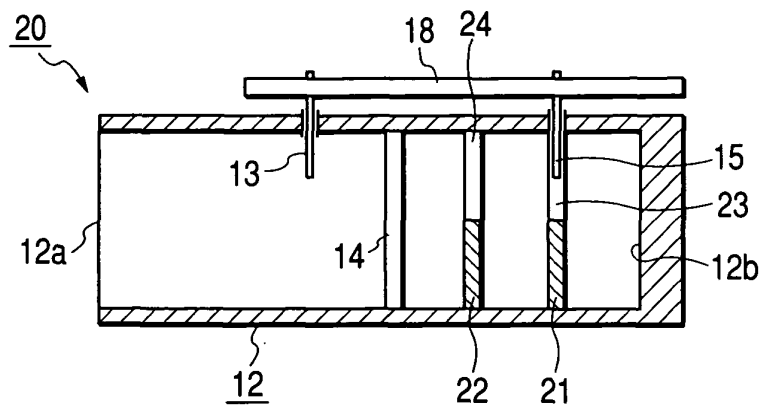


FIG. 5

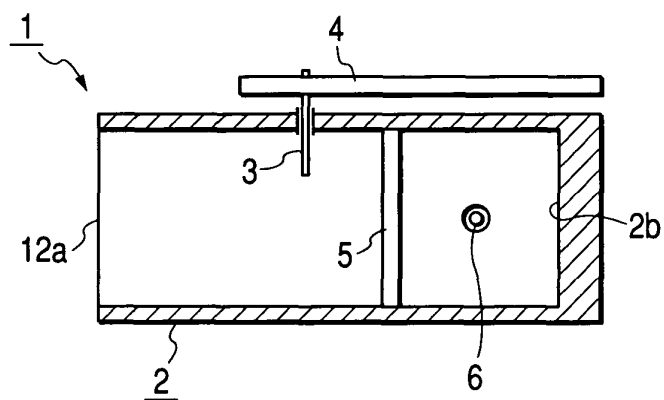
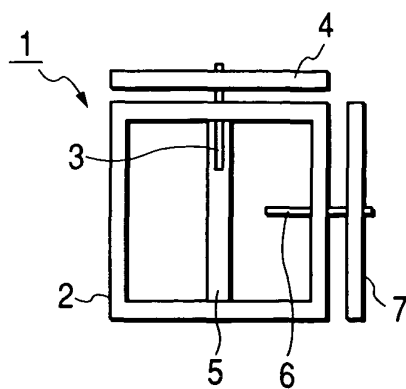


FIG. 6





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 00 6861

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CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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