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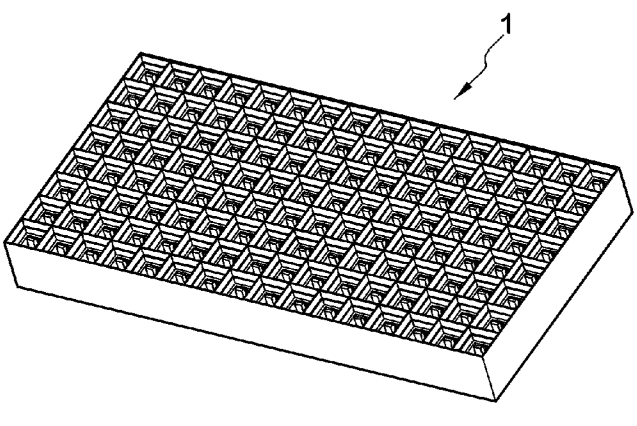
(54) Title: HORN ARRAY TYPE ANTENNA FOR DUAL LINEAR POLARIZATION

[Fig. 49]



(57) Abstract: A horn array antenna for dual linear polarization is provided, which includes at least one horn tapered along the advancing direction of the electromagnetic waves to guide the electromagnetic waves, and having a polarization filtering unit to separate the first and second polarization whose directions of electric field is orthogonal t each other, a first polarization guide to guide the first polarization separated at the polarization filtering unit, and a second polarization guide to guide the second polarization separated at the polarization filtering unit. Accordingly, an antenna with improved performance and reduced size is provided.

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Description

HORN ARRAY TYPE ANTENNA FOR DUAL LINEAR POLARIZATION

Technical Field

[1] The present invention relates to a horn array type antenna for dual linear polarization, and more particularly, a horn array type antenna for dual linear polarization for improving an antenna performance and reducing a size of antenna.

Background Art

[2] Waves traveling higher than ultrahigh frequency have very short wavelengths and have characteristics similar to light. In order to effectively receive and transmit such waves, the technology has advanced itself to improve the directivity, applying optics theory or the theory that says a megaphone concentrates a sound wave. Such antennas, with enhanced directivity, are known as horn antenna, parabola antenna, lens antenna, and slot antenna which have waveguides with holes formed thereon.

[3] Among these, the horn antenna is formed of a waveguide with one end formed in a horn shape and opened at both ends. The horn antenna propagates electromagnetic waves along the waveguide by vibrating one end of the waveguide so as to radiate to the air. As the impedance between the waveguide and the air is not matching, it reflects a part of the electromagnetic wave, which means that the entire energy is not radiated to the air. Therefore, a horn antenna is designed to have its waveguide opening to be gradually wider so that it matches the impedance between the air and the waveguide and allows it to maximally radiate energy through the opening. Fig. 1 is the cross-sectional view of a horn in a general horn antenna.

[4] In Fig. 1, the horn antenna shows an outer opening 2 facing the air, and an inner opening 3 at a side where the vibration starts. In such an antenna, the size of the outer opening 3 decides the performance of the antenna. The wider the size of the outer opening 3 is, the better the performance is provided. A ratio (S_2/S_1) of the size of the outer opening 2 and that of the inner opening 3 influences the performance of the antenna. The ratio (S_2/S_1) of the size of the outer opening 2 and the inner opening 3, i.e., the difference between the size of the outer opening 2 and that of the inner opening 3 and the gradient of the horn are important factors that decide the performance. Therefore, the horn should be longer and accordingly the overall size of the antenna should be larger.

[5] The present trend of the development of communication technology is towards

compactness.

[6] Accordingly, the demand persists that technology develop a method to reduce the size of an antenna while improving, or at least sustaining its performance.

Disclosure of Invention

Technical Problem

[7] Therefore, an object of the present invention is to provide a horn array antenna for dual linear polarization having an improved antenna performance and a small size.

[8] Another object of the present invention is to provide a horn array antenna having a skew filter capable of changing the directivity of the polarization wave, which is inappropriate for an antenna to receive, toward appropriate direction.

Technical Solution

[9] In order to achieve the objects of the present invention, a horn array antenna for dual linear polarization for receiving a first polarization and a second polarization is provided, which includes a plurality of horns to which the first and second polarizations enter together, a plurality of polarization filtering units provided to the horns, to separate the first and second polarizations from the mixture of the first and second polarizations entering the horns, a first polarization guide to guide the first polarization which is separated at the polarization filtering units, and a second polarization guide to guide the second polarization which is separated at the polarization filtering units. The first polarization guide includes a first guide unit to receive the first polarization through one and the other ends thereof, the first polarization received having been separated at the first and second polarization filtering units, a second guide unit to receive the first polarization through one and the other ends thereof, the first polarization received having been separated at the third and fourth polarization filtering units, a first relay unit to connect a portion of the first guide unit with a portion of the second guide unit, and mix the first polarization provided from the first and second guide units, and a first mixing unit connected to a portion of the first relay unit, to receive the first polarization mixed at the first relay unit.

[10] According to an aspect of the present invention, a horn array antenna for dual linear polarization for receiving a first polarization and a second polarization, includes a plurality of horns to which the first and second polarizations enter together, a plurality of polarization filtering units provided to the horns, to separate the first and second polarizations from the mixture of the first and second polarizations entering the horns, a first polarization guide to guide the first polarization which is separated at the po-

larization filtering units, and a second polarization guide to guide the second polarization which is separated at the polarization filtering units. The second polarization guide includes a first direction changing unit to change an advancing direction of the second polarization provided from the first polarization filtering unit, a second direction changing unit to change an advancing direction of the second polarization provided from the second polarization filtering unit, a third direction changing unit to change an advancing direction of the second polarization provided from the third polarization filtering unit, a fourth direction changing unit to change an advancing direction of the second polarization provided from the fourth polarization filtering unit, a first guide unit to connect the first and third direction changing units, and mix the second polarization provided from the first and third direction changing units, a second guide unit to connect the second and fourth direction changing units, and mix the second polarization provided from the second and fourth direction changing units, a first relay unit to connect a portion of the first guide unit with a portion of the second guide unit, and mix the second polarization provided from the first and second guide units, and a first mixing unit connected to a portion of the first relay unit, to guide so that the second polarization provided from the first relay unit is emerged.

[11] According to another aspect of the present invention, a horn array antenna for dual linear polarization for receiving a first polarization and a second polarization, includes a plurality of horns to which the first and second polarizations enter together, a plurality of polarization filtering units to separate the first and second polarizations from the mixture of the first and second polarizations entering the horns, a first polarization guide to guide the first polarization which is separated at the polarization filtering units, and a second polarization guide to guide the second polarization which is separated at the polarization filtering units. An upper portion of the polarization filtering unit is in a square box shape, and a lower portion of the polarization filtering unit is in a narrower square box shape.

[12] According to yet another aspect of the present invention, a horn array antenna for dual linear polarization for receiving a first polarization and a second polarization, includes a plurality of horns to which the first and second polarizations enter together, a plurality of polarization filtering units to separate the first and second polarizations from the mixture of the first and second polarizations entering the horns, a first polarization guide to guide the first polarization which is separated at the polarization filtering units, a second polarization guide to guide the second polarization which is separated at the polarization filtering units, and a skew filter to change an angle of at

least one of the first and second polarizations.

[13] According to yet another aspect of the present invention, a horn array antenna includes a plurality of horns to which electromagnetic waves enter, a guide to guide the electromagnetic waves entering into the horns, and a skew filter to change an angle of the electromagnetic waves.

Advantageous Effects

[14] As described above, according to the present invention, the performance of the antenna can be improved while the size of the antenna is reduced.

[15] Furthermore, a skew filter is applicable to the horn array antenna to change a direction of electric field of the polarization to an appropriate direction, if the polarization has a direction of electric field inappropriate for the antenna to receive. As a result, the antenna has improved receptivity.

Brief Description of the Drawings

[16] Fig. 1 is a cross section view of a conventional horn antenna;

[17] Fig. 2 is a plan view illustrating the antenna unit of a horn array antenna for dual polarization wave according to an embodiment of the present invention;

[18] Figs. 3 and 4 are a perspective view and a transparent perspective view illustrating the antenna unit of Fig. 2;

[19] Fig. 5 is a perspective view of the horn of the horn array antenna for dual linear polarization according to an embodiment of the present invention;

[20] Fig. 6 is a transparent perspective view of the horns of Fig. 5;

[21] Fig. 7 is a transparent side view of the horn of Fig. 5;

[22] Fig. 8 is a partially cutaway perspective view of the horn of Fig. 5;

[23] Figs. 9 and 10 are a perspective view and a transparent perspective view illustrating the polarization filtering unit of Fig. 5 to show the traveling path of the electromagnetic waves;

[24] Figs. 11 and 12 are a perspective view and a transparent perspective view of the polarization filtering unit of Fig. 9 viewed from a different angle;

[25] Fig. 13 is a top view of the polarization filtering unit of Fig. 11;

[26] Figs. 14 to 16 are side views of the polarization filtering unit having different shapes of radiation protrusions according to embodiments of the present invention;

[27] Fig. 17 is a side view of a polarization filtering unit according to an embodiment of the present invention;

[28] Figs. 18 to 20 illustrate the examples of the interference protrusions in square,

triangular, and semicircular shapes;

[29] Figs. 21 to 23 illustrate the examples where the interference preventive hole is formed in square, triangular and semicircular configuration;

[30] Fig. 24 is a side cross-sectional view of the horn according to an embodiment of the present invention;

[31] Fig. 25 is a side cross-sectional view of the horn having the same length as that of the outer opening which is in the same size as the horn;

[32] Fig. 26 is a side cross-sectional view of the horn having the same performance as the horn of Fig. 24

[33] Figs. 27 and 28 are a perspective view and a transparent perspective view of the first and second polarization guides of Fig. 2 being engaged with each other;

[34] Fig. 29 is a plan view of the first polarization guide engaged with the polarization filtering unit;

[35] Fig. 30 is a perspective view of the first polarization guide of Fig. 29;

[36] Fig. 31 is a transparent perspective view of the first polarization guide of Fig. 30;

[37] Fig. 32 is a plan view of the second polarization guide;

[38] Fig. 33 is a perspective view of the second polarization guide of Fig. 32;

[39] Fig. 34 is a transparent perspective view of the second polarization guide of Fig. 33;

[40] Fig. 35 is an exploded perspective view of each layer of the horn array antenna for dual linear polarization;

[41] Fig. 36 is a plan view of the first layer of Fig. 35;

[42] Fig. 37 is a perspective view of the first layer of Fig. 35;

[43] Fig. 38 is a plan view of the second layer of Fig. 35;

[44] Fig. 39 is a perspective view of the second layer;

[45] Fig. 40 is a rear view of the second layer;

[46] Fig. 41 is a plan view of the third layer of Fig. 35;

[47] Fig. 42 is a perspective view of the third layer;

[48] Fig. 43 is a rear view of the third layer;

[49] Fig. 44 is a plan view of the fourth layer of Fig. 35;

[50] Fig. 45 is a perspective view of the fourth layer;

[51] Fig. 46 is a rear view of the fourth layer;

[52] Fig. 47 is a plan view of the fifth layer;

[53] Fig. 48 is a perspective view of the fifth layer;

[54] Fig. 49 is a perspective view of the horn array antenna in use according to an embodiment of the present invention;

[55] Fig. 50 is a perspective view of the first layer;

[56] Fig. 51 is a plan view of the second layer;

[57] Fig. 52 is a perspective view of the second layer;

[58] Fig. 53 is a rear view of the second layer;

[59] Fig. 54 is a plan view of the third layer of the horn array antenna of Fig. 49;

[60] Fig. 55 is a perspective view of the third layer;

[61] Fig. 56 is a rear view of the third layer;

[62] Fig. 57 is a plan view of the fourth layer of Fig. 49;

[63] Fig. 58 is a perspective view of the fourth layer;

[64] Fig. 59 is a rear view of the fourth layer;

[65] Fig. 60 is a front view of the fifth layer of Fig. 49;

[66] Fig. 61 is a perspective view of the fifth layer;

[67] Fig. 62 is a rear view of the fifth layer;

[68] Figs. 63 and 64 are plan views illustrating the 1:1 splitters according to embodiments of the present invention;

[69] Figs. 65 to 67 are plan views illustrating m:n splitters according to embodiments of the present invention;

[70] Figs. 68 to 70 are views provided to explain the concept of a skew filter;

[71] Figs. 71 to 78 illustrate a method for applying a skew filter to the horn array antenna for dual linear polarization according to embodiments of the present invention;

[72] Figs. 79 to 83 are views illustrating the variations of the skew filter;

[73] Figs. 84 to 86 illustrate skew filters whose ends are not in contact with the edges of the inner opening;

[74] Fig. 87 is a view illustrating an example of employing a skew filter when the horn is not parallel with the polarization filtering unit;

[75] Figs. 88 and 89 are views illustrating examples of a spacer;

[76] Fig. 90 is a perspective view of a horn array antenna for single linear polarization applicable to the embodiments of the present invention;

[77] Fig. 91 is an exploded perspective view illustrating the layers of the horn array antenna of Fig. 90;

[78] Fig. 92 is a perspective view of the first layer;

[79] Fig. 93 is a plan view of the first layer viewed from above;

[80] Fig. 94 is a rear view of the first layer viewed from under;

[81] Fig. 95 is a perspective view of the second layer;

[82] Fig. 96 is a plan view of the second layer viewed from above;

[83] Fig. 97 is a rear view of the second layer viewed from under;

[84] Fig. 98 is a perspective view of the third layer;

[85] Fig. 99 is a plan view of the third layer viewed from above;

[86] Fig. 100 is a rear view of the third layer viewed from under;

[87] Figs. 101 to 103 are views provided to explain concept of a skew filter; and

[88] Figs. 104 to 107 are views illustrating a method for applying a skew filter to the horn array antenna for single linear polarization according to embodiments of the present invention.

Best Mode for Carrying Out the Invention

[89] The present invention will be explained in greater detail with reference to the accompanying drawings.

[90] A horn array antenna for dual linear polarization according to embodiments of the present invention is capable of both receiving and transmitting electromagnetic waves. However, for convenience of explanation, the operations of each component part of the horn array antenna will be focused mainly on the receiving end, and then the operations of the horn array antenna as a transmitting end will be explained in the later part of the description.

[91] According to one aspect of the present invention, the first polarization wave is a horizontal (H) polarization which is parallel to the equator of the earth, while the second polarization wave is a vertical (V) polarization which is perpendicular to the equator.

[92] Fig. 2 is a plan view illustrating the antenna unit of a horn array antenna for dual polarization wave according to an embodiment of the present invention, and Figs. 3 and 4 are perspective view and a transparent perspective view illustrating the antenna unit of Fig. 2.

[93] The horn array antenna 1 for dual linear polarization includes a plurality of horns 10 to which electromagnetic waves enter, a first polarization guide 30 to guide a first polarization wave of the electromagnetic waves introduced into the horns 10, and a second polarization guide 50 to guide a second polarization wave of the electromagnetic waves introduced into the horns 10.

[94] Each of the horns 10 is open to space, and has the first polarization guide 30 at a lower portion. The second polarization guide 50 is formed on the lower portion of the first polarization guide 30. The horns 10, and the first and second polarization guides 30, 50 are the spaces where the electromagnetic waves travel. The horns 10, and the first and second polarization guides 30 and 50 are formed on the basis of layers, and

the configurations of these layers will be explained below.

[95] The antenna unit illustrated in Figs. 2 to 4 is the smallest unit of the antenna that can process the first and second polarization waves in the horn array antenna for dual linear polarization. One antenna unit includes four horns 10, one first polarization guide 30 and one second polarization guide 50. The horn array antenna 1 for dual linear polarization will be explained in detail below with reference to the antenna unit.

[96] Fig. 5 is a perspective view of the horn of the horn array antenna for dual linear polarization according to an embodiment of the present invention, Fig. 6 is a transparent perspective view of the horns of Fig. 5, Fig. 7 is a transparent side view of the horn of Fig. 5, and Fig. 8 is a partially cutaway perspective view of the horn of Fig. 5.

[97] The horn 10 guides the electromagnetic waves so that the first and second polarization waves can be introduced into the plane of incidence at orthogonal relation with respect to each other. The horn 10 includes an inclined portion 15 configured in a quadrangular pyramid shape, and a polarization filtering unit 20 formed on one end of the inclined portion 15.

[98] The inclined portion 15 is tapered along the advancing direction of the electromagnetic waves, and open at opposite ends also along the advancing direction of the electromagnetic waves. That is, the inclined portion 15 includes an outer opening which is open outward at one end, and an inner aperture in a square shape in the inside of the opposite end which is relatively narrower in width. The inner aperture includes a first protrusion 17 extending from a side toward the center area, and the first protrusion 17 is formed around the inner aperture to a predetermined depth. The inclined portion 15 includes a second protrusion 18 which is formed on an inclined plane between the outer opening and the first protrusion 17, and is extended around the inclined portion 15. The second protrusion 18 is in parallel relation with respect to the first protrusion 17. If more than at least one protrusion 17, 18 is formed, the horn antenna can have uncompromised, or even improved performance, and accordingly, the horn antenna can have reduced height. According to one embodiment of the present invention, two protrusions 17, 18 are provided. However, this is only for exemplary purpose, and one will understand that the number of protrusions 17, 18 may vary as occasion demands.

[99] Figs. 9 and 10 are a perspective view and a transparent perspective view illustrating the polarization filtering unit of Fig. 5 to show the traveling path of the electromagnetic waves, Figs. 11 and 12 are a perspective view and a transparent perspective view of the polarization filtering unit of Fig. 9 viewed from a different angle, Fig. 13 is a top view of the polarization filtering unit of Fig. 11, and Figs. 14 to

16 are side views of the polarization filtering unit having different shapes of radiation protrusions 22 according to embodiments of the present invention.

[100] The polarization filtering unit 20 is connected to the inner aperture of the inclined portion 15. Four polarization filtering units 20 are mounted to one antenna unit. The polarization filtering unit 20 passes the second polarization only, and so blocks the first polarization. Accordingly, the first polarization, which is not passed through the polarization filtering unit 20, is guided to the first polarization guide 30, while the second polarization is passed through the steps 25 of the polarization filtering unit 20 and guided to the second polarization guide 50.

[101] Accordingly, the polarization filtering unit 20 is formed in a manner in which its width gradually narrows from the upper portion connected to the inclined portion 15, toward the lower portion. The uppermost portion of the polarization filtering unit 20, which is connected to the inner aperture of the inclined portion 15, has a square box shape extending downward from the inner side, and one sidewall of the polarization filtering unit 20 is formed a predetermined distance downward from the first protrusion 17 and extended to the inner space. Accordingly, the width of the polarization filtering unit 20 is narrowed toward one direction and thus formed in a rectangular shape, in which the width in the same direction as that of the electric field of the second polarization wave is narrowed.

[102] A first polarization introducing path 21 is formed on this one inwardly protruding sidewall, to guide the first polarization, which is unable to advance downward in the polarization filtering unit 20, toward the first polarization guide 30. The first polarization introducing path 21 is extended along the advancing direction of the first polarization in a long square box shape, and as shown in Fig. 13, is arranged in the center area along the width direction of the one sidewall of the polarization filtering unit 20. A radiation protrusion 22 extends from the lower portion close to the entrance end of the first polarization introducing path 21, toward the inner portion of the first polarization introducing path 21. The radiation protrusion 22 extends a predetermined distance downward from the entrance of the first polarization introducing path 21, thereby causing the lower inner portion of the first polarization introducing path 21 to form stepwise configuration.

[103] The radiation protrusion 22 causes the entrance portion of the first polarization introducing path 21 to be narrowed in a vertical direction, thereby helping the first polarization from the polarization filtering unit 20 to improve feed characteristic when entering the first polarization introducing path 21. The radiation protrusion 22 may be

formed in a variety of configurations. For example, as shown in Fig. 14, the radiation protrusion 22 formed in square step configuration may be provided, or as shown in Fig. 15, the radiation protrusion 22 may be formed so as to inclindingly connect the polarization filtering unit 20 with the first polarization introducing path 21, or as shown in Fig. 16, the radiation protrusion 22 may be formed as a curved protrusion.

[104] On the lower portion of the first polarization introducing path 21, there are provided a sidewall on which the first polarization introducing path 21 is formed, and a step 25 having an inwardly protruding wall facing the above sidewall. One or a plurality of steps 25 may be provided, and the step 25 may be formed only on one sidewall or on two opposite sidewalls. Referring to Figs. 14 to 16, the polarization filtering unit 20 includes two steps, in which one is formed on one sidewall and the other is formed on the opposite sidewall. On the contrary, the polarization filtering unit 20 of Fig. 17 has a plurality of steps starting from the top portion and continuing downward by predetermined lengths on only one sidewall.

[105] Due to the presence of the step(s) 25, the polarization filtering unit 20 has a gradually narrowing width in a predetermined direction, and as a result, the first and second polarizations passing the polarization filtering unit 20 are separated from each other and fed to the first and second polarization guides 30 and 50, respectively. Specifically, the first polarization, which has the same directivity as that of the wider width portion of the polarization filtering unit 20, is fed to the first polarization guide 30, while the second polarization, which has the same directivity as that of the narrower width portion of the polarization filtering unit 20, is moved along the polarization filtering unit 20 and fed to the second polarization guide 50. The number, sizes and lengths of steps 25 may vary according to the frequency of the second polarization which is guided along the second polarization guide 50.

[106] Meanwhile, on the opposite sidewall, an interference protrusion 19 extends from a position that corresponds to the first polarization introducing path 21. The interference protrusion 19 prevents the second polarization from interfering with the first polarization guide 30, and may be formed in various different shapes such as square, rectangle, ellipse, semicircle, or the like. Figs. 18 to 20 illustrate the examples of the interference protrusions 19 in square, triangular, and semicircular shapes.

[107] As an alternative to the interference protrusion 19, an interference preventive hole 19a may be formed by boring in a wall that faces the first polarization introducing path 21. The interference preventive hole 19a may be formed in the place of the interference protrusion 19 in square, rectangular, triangular, elliptical, or semicircular

configuration. Figs. 21 to 23 illustrate the examples where the interference preventive hole 19a is formed in square, triangular and semicircular configuration.

[108] The first polarization has the improved S11 parameter, as the interference protrusion 19 or the interference preventive hole 19a prevents potential interference with the second polarization. The interference protrusion 19 or the interference preventive hole 19a may have different structure, depending on the structure of the first and second polarization guides, and also have different positions or sizes depending on the frequency of the first and second polarizations.

[109] Fig. 24 is a side cross-sectional view of the horn according to an embodiment of the present invention, Fig. 25 is a side cross-sectional view of the horn having the same length as that of the outer opening which is in the same size as the horn, and Fig. 26 is a side cross-sectional view of the horn having the same performance as the horn of Fig. 25.

[110] The horn 110 illustrated in Fig. 25 has the length of 61.0 mm according to an embodiment of the present invention, and the horn 210 illustrated in Fig. 26 has the length of 71.0 mm. All the horns 10, 110, 210 have the outer openings which have the same width, that is, 48.0 mm. Table 1 below illustrates the result of comparing the antenna gains of these three horns 10, 110, 210 in the satellite broadcast band (KU BAND) of 10.7 GHz to 12.75 GHz, with the center frequency of 11.7 GHz, upper sideband of 12.75 GHz, and lower sideband of 10.7 GHz.

[111] Table 1

[Table 1]

[Table]

	Present invention	Fig. 25	Fig. 26
10.7 GHz	14.8[dBi]	14.3[dBi]	14.8[dBi]
11.7 GHz	15.8[dBi]	15.1[dBi]	15.8[dBi]
12.7 GHz	16.1[dBi]	15.6[dBi]	16.1[dBi]

[112] As the above table shows, the horn 10 of the present invention, and the horn 210 of Fig. 26 which is designed to be longer than the horn 10 by 10.0 mm, both exhibit the same level of performance. However, the horn 110 of Fig. 25, which has the same length as the horn 10 of the present invention, and the outer opening in the same size as that of the horn 10 of the present invention, exhibits lower antenna gain than the horn 10 of the present invention by 0.5 dBi in the band of 10.7 GHz, 0.7 dBi in the

band of 11.7 GHz, and 0.5 dBi in the band of 12.7 GHz. It is generally recognized that a difference of 1 dBi of the antenna gain corresponds to 33% of difference in the performance. Taking this into account, the horn 10 according to the present invention can have approximately 18% of improvement of performance, when compared to the conventional horn of the same size. Furthermore, the horn 10 according to the present invention has a reduced height than the horn 210 of Fig. 26, and thus can have a smaller size.

[113] Even when the first protrusion 17 alone is formed on the inner aperture of the inclined portion 15, the inclined portion 15 can still have the reduced length, while maintaining the widths of the inner and outer openings.

[114] Figs. 27 and 28 are a perspective view and a transparent perspective view of the first and second polarization guides of Fig. 2 being engaged with each other, Fig. 29 is a plan view of the first polarization guide engaged with the polarization filtering unit, Fig. 30 is a perspective view of the first polarization guide of Fig. 29, and Fig. 31 is a transparent perspective view of the first polarization guide of Fig. 30.

[115] The first polarization guide 30 guides and emits the first polarization introduced into the four horns 10, and has four openings on four corners which are connected to the first polarization introducing path 21 formed on the four polarization filtering unit 20.

[116] The first polarization guide 30 includes a first and second guide units 31, 32 to interconnect a pair of first neighboring polarization introducing paths 21, a first relay unit 40 to connect the first guide unit 31 to the second guide unit 32, and a first mixing unit 45 extending from the center area of the first relay unit 40.

[117] One and the other ends of the first guide unit 31 are connected to the pair of first polarization introducing paths 21, at a perpendicular relation with each of the first polarization introducing paths 21.

[118] A pair of first introducing guide surfaces 33 are connected to one and the other ends of the first guide unit 31, each having an inclined outer edge at an end that is connected to the first polarization introducing path 21. Accordingly, the first polarization is introduced into the pair of first polarization introducing paths 21, and varies its direction due to the first introducing guide surfaces 33 to be guided to the first guide unit 31.

[119] One and the other ends of the second guide unit 32 are also connected to a pair of first polarization introducing paths 21, and also connected to a pair of second introducing guide surfaces 34 each having an inclined outer edge at an end that is connected to one and the other ends of the second guide unit 32. Accordingly, the

second polarization is introduced into the pair of first polarization introducing paths 21, and guided along the second introducing guide surfaces 34 toward the second guide unit 32.

[120] The first and second guide units 31, 32 may be provided in tubular forms, each of the tube having narrower center in width than one and the other ends. To do so, diameter reducing portions 35, 36 may be extended inward from the tubes, toward the center areas of the first and second guide units 31, 32. The widths of the first and second guide units 31, 32 depend on the lengths of the diameter reducing portions 35, 36, and the center frequency of the first polarization being introduced into the first mixing unit 45 depends on the widths of the first and second guide units 31, 32. In other words, by adjusting the widths and lengths of the diameter reducing portions 35, 36, the center frequency of the first polarization being introduced into the first mixing unit 45 can be varied.

[121] While the diameter reducing portions 35, 36 are formed on the walls that adjoin the first guide unit 31, second guide unit 32, and first relay unit 40, may other alternatives are also possible. For example, the diameter reducing portions 35, 36 may be formed on the wall that faces the wall adjoined with the first relay unit 40. Also, the diameter reducing portions 35, 36 may be formed on both the wall that adjoin the first guide unit 31 and the wall that faces the wall the adjoin the first guide unit 31.

[122] The first and second guide units 31, 32 are arranged in parallel so that the first and second introducing guide surfaces 33, 34 are inclined to the same direction.

[123] The first relay unit 40 interconnects the middle portions of the first and second guide units 31, 32. A pair of slant tubes 41 are formed on one and the other ends of the first relay unit 40, extending for a predetermined distance from the linking areas with the first and second guide units 31, 32, and being inclined to a predetermined direction. The slant tubes 41 are connected with each other by a linear tube which is formed in narrow width than each of the slant tubes 41.

[124] A first mixing unit 45 is formed on the middle portion of the linear tube, to mix the first polarization which is introduced through the first and second guide units 31, 32. The first mixing unit 45 extends from the middle portion of the first relay unit 40, bent once to parallel relation with the first relay unit 40, and bent again to form a right angle with the first relay unit 40. As a result, the first mixing unit 45 has a '□' configuration. A first and second slant surfaces 46, 47 are formed on the outer edges of the two bent portions of the first mixing unit 45, thereby changing the advancing direction of the first polarization. Accordingly, the first polarization from the first relay unit 40 is

mixed at the first mixing unit 45, changes the direction of movement due to the first and second slant surfaces 46, 47, and is output from the antenna unit.

[125] The first polarization, which is output from the antenna unit, is mixed with the first polarization which is output from the other antenna units, and output to outside. The movement of the first polarization after being output from the antenna units will be explained below.

[126] In the first polarization guide 30, the first guide unit 31 is formed in symmetrical structure, and the second guide unit 32 is also formed in symmetrical structure. Accordingly, the first polarization, which is introduced into one and the other ends of the first guide unit 31, has the same phase when it reaches the first relay unit 40, and likewise, the first polarization, which is introduced into one and the other ends of the second guide unit 32, also has the same phase when it reaches the first relay unit 40. As a result, the first polarization, which is introduced into one and the other ends of the first guide unit 31 and mixed at the first relay unit 40, and the first polarization, which is introduced into one and the other ends of the second guide unit 40 and mixed at the first relay unit 40, are prevented from experiencing offset or changes due to phase difference.

[127] Fig. 32 is a plan view of the second polarization guide, Fig. 33 is a perspective view of the second polarization guide of Fig. 32, and Fig. 34 is a transparent perspective view of the second polarization guide of Fig. 33.

[128] The second polarization guide 50 is arranged parallel with the first polarization guide 30, receives the second polarization transferred via the polarization filtering unit 20, and outputs the received second polarization.

[129] The second polarization guide 50 includes a first to fourth direction changing units 51, 52, 53, 54 to change the direction of the second polarization which is transferred via the respective polarization filtering units 20, a third guide unit 55 to connect the first direction changing unit 51 with the third direction changing unit 53, a fourth guide unit 60 to connect the second direction changing unit 52 with the fourth direction changing unit 54, a second relay unit 63 to connect the third guide unit 55 with the fourth guide unit 60, and a second mixing unit 65 to mix the second polarization received from the third guide unit 55 and the fourth guide unit 60.

[130] The first to fourth direction changing units 51, 52, 53, 54 are connected with the polarization filtering units 20, respectively, with each of the direction changing units 51, 52, 53, 54 having a protruding end 68 and a reflecting surface 69. Each of the protruding ends 68 extend from an end of the direction changing unit 51, 52, 53, 54

which faces the polarization filtering unit 20, that is, the protruding ends 68 each extends upward from the bottom of the direction changing unit 51, 52, 53, 54. The protruding ends 68 is each configured as a square box having one sidewall that is connected to the third and fourth guide units 55, 60 inclined.

[131] The second polarization, having directivity toward the narrower width of the polarization filtering unit 20, changes its direction upon hitting the protruding end 68. Each of the reflecting surfaces 69 is inclined at a predetermined angle and formed on a surface that faces the protruding end 68, to reflect the second polarization whose direction is changed due to the protruding end 68, so that the second polarization is provided to the third and fourth guide units 55, 60.

[132] The first and second direction changing units 51, 52 are formed parallel with each other so that the reflecting surface 69 and the protruding end 68 corresponds to each other, and the third and fourth direction changing units 53, 54 are also formed parallel with each other so that the reflecting surface 69 and the protruding end 68 corresponds to each other. The reflecting surfaces 69 of the first and third direction changing units 5, 53 are symmetrical, that is, in a mirror image, and the reflecting surfaces 69 of the second and fourth direction changing units 52, 54 are also formed symmetrical in a mirror image.

[133] Meanwhile, the third guide unit 55 mixes the second polarization, whose direction is changed at the first and third direction changing units 51, 53, and provides it to the second mixing unit 65, and the fourth guide unit 60 mixes the second polarization, whose direction is changed at the second and fourth direction changing units 52, 54, and provides it to the second mixing unit 65. The third and fourth guide units 55, 60 are formed in symmetry with each other with respect to the second mixing unit 65.

[134] The third and fourth guide units 55, 60 have ends that are connected to the first to fourth direction changing units 51, 52, 53, 54, and that are narrower than the middle portions. Accordingly, steps 57, 62 are formed on two portions in horizontal width direction, in between one and the other ends of the third guide unit 55 and one and the other ends of the fourth guide unit 60. Alternatively, only one step, or a plurality of steps 57, 62 may be formed in a length direction of the third and fourth guide units 55, 60.

[135] The third and fourth guide units 55, 60 are connected to each other by the second relay unit 63 by their middle portions. The second relay unit 63 is formed as a linear tube, which has a narrower middle portion than one and the other ends in the length direction thereof. To do this, there is a protrusion 64 extending inward from a sidewall

connected to the second mixing unit 65 on a middle portion of the second relay unit 63.

[136] Although the protrusion 64 is formed only one sidewall that is connected to the second mixing unit 65, this is not limiting. Accordingly, another protrusion 64 may also be formed on an opposite sidewall. Furthermore, more than two protrusions 64 may be formed, and lengths of the protrusion 64 may be adjusted. By adjusting the number, length and width of the protrusions 64, it is possible to adjust the frequency of the second polarization which is mixed at the second mixing unit 65.

[137] The second mixing unit 65 extends from a middle portion of the second relay unit 63, bent once to a parallel relation with the second relay unit 63, and bent second time to form a right angle with the second relay unit 63, thereby forming, as a whole, a 'ㄱ' configuration. A third and fourth slant surfaces 66, 67 are formed on the outer edges of the two bent portions of the second mixing unit 65, to change a direction of the second polarization. As a result, the second polarization from the second relay unit 63 is mixed at the second mixing unit 65, changes direction of movement due to the third and fourth slant surfaces 66, 67, and is output from the antenna unit. After being output from the antenna unit, the second polarization is mixed with the second polarization output from the other antenna units, and discharged to outside. The movement of the second polarization after being output from the antenna units will be explained below.

[138] The process in which the first and second polarizations are split and received at the horn array antenna 1 for dual linear polarization according to the above embodiments of the present invention will be explained below.

[139] Electromagnetic waves are introduced through the horn 10, guided along the inclined portion 15, passed the first and second protrusions 17, 18, and provided to the polarization filtering unit 20.

[140] One end of the polarization filtering unit 20 becomes gradually narrower due to the presence of a plurality of steps 25, and as a result, the first polarization having the same directivity as that of the wider width of the polarization filtering unit 20 does not pass the polarization filtering unit 20, but fed via the first polarization introducing path 21 to the first polarization guide 30. The second polarization having the same directivity as that of the narrower width of the polarization filtering unit 20 is passed downward along the polarization filtering unit 20 and introduced into the second polarization guide 50.

[141] Among the electromagnetic waves introduced through the four horns 10, the first polarization is introduced into one and the other ends of the first and second guide units

31, 32. The first polarization introduced into one and the other ends of the first guide unit 31 is mixed at one end of the first relay unit 40, and the first polarization input into one and the other ends of the second guide unit 32 is mixed at the other end of the first relay unit 40.

[142] After being input into one and the other ends of the first relay unit 40, the first polarization meets in the middle portion of the first relay unit 40 and guided to the first mixing unit 45. The first polarization moved from one and the other ends of the first relay unit 40 is mixed in the first mixing unit 45, and after changing a direction due to the first and second slant surfaces 46, 47, the first polarization exits out of the first mixing unit 45.

[143] Meanwhile, the second polarization, after being guided into the second polarization guide 50 through the polarization filtering unit 20, has the same directivity as that of the narrower width of the polarization filtering unit 20. The second polarization is moved to the first to fourth direction changing units 51, 52, 53, 54, and hits the protruding ends 68 of the first to fourth direction changing units 51, 52, 53, 54, thereby changing the direction.

[144] The second polarization is reflected against the reflecting surfaces 69 of the first to fourth direction changing units 51, 52, 53, 54, and moved to the third or fourth guide unit 55, 60. The second polarization coming from the first and third direction changing units 51, 53 are mixed at the middle portion of the third guide unit 55, and the second polarization coming from the second and fourth direction changing units 52, 54 are mixed at the middle portion of the fourth guide unit 60. The second polarization coming from the third and fourth guide units 55, 60 are input into one and the other ends of the second relay unit 63, mixed at the middle portion of the second relay unit 63, and provided to the second mixing unit 65. The second polarization, after being mixed at the second mixing unit 65, changes its direction as it passes the third and fourth slant surfaces 66, 67, and is discharged to outside.

[145] The process in which the first and second polarizations are transmitted at the horn array antenna 1 for dual linear polarization will be explained below.

[146] The second polarization introduced into the second mixing unit 65 of the second polarization guide 50 is split into two branches at the middle portion of the second relay unit 63, guided into the third and fourth guide units 55, 60, and so is moved along the third and fourth guide units 55, 60 to advance to one and the other ends of the third and fourth guide units 55, 60. The second polarization, after split, is reflected against the reflecting surfaces 69 of the direction changing units 51, 52, 53, 54 and provided to the

protruding ends 68, respectively. The second polarization changes its direction of movement toward the polarization filtering unit 20 due to the protruding ends 68, and ascends through the polarization filtering unit 20.

[147] Meanwhile, the first polarization introduced into the first mixing unit 45 of the first polarization guide 30 is split at the middle portion of the first relay unit 40, and moved to one and the other ends of the first relay unit 40. As the first polarization as split meets the first and second guide units 31, 32 connected to one and the other ends of the first relay unit 40, the first polarization is split again to be guided to one and the other ends of the first and second guide units 31, 32. At one and the other ends of the first and second guide units 31, 32, the first polarization changes its direction to move toward the first polarization introducing path 21 due to the presence of the first and second introducing guide surfaces 33, 34, so that the first polarization is passed through the first polarization introducing path 21 and provided to the polarization filtering units 20, respectively. After being output to the polarization filtering unit 20, the first polarization joins with the second polarization from the second polarization guide 50, and radiated to the air via the inclined portion 15.

[148] As mentioned above, the horn array antenna 1 for dual linear polarization is made of layers, and these will be explained in detail below with reference to the antenna units.

[149] Fig. 35 is an exploded perspective view of each layer of the horn array antenna for dual linear polarization, Fig. 36 is a plan view of the first layer of Fig. 35, and Fig. 37 is a perspective view of the first layer of Fig. 35.

[150] The horn array antenna for dual linear polarization according to an embodiment of the present invention includes a first layer 100, a second layer 150, a third layer 200, a fourth layer 250, and a fifth layer 300.

[151] The first layer 100 includes the inclined portion 15 and the first and second protrusions 17, 18 of the horn 10, in which the inclined portion 15 is formed on a planar side, and the inner aperture is formed on a rear side of the first layer 100.

[152] Fig. 38 is a plan view of the second layer of Fig. 35, Fig. 39 is a perspective view of the second layer, and Fig. 40 is a rear view of the second layer.

[153] The second layer 150 includes the polarization filtering unit 20 which is connected to the inner aperture of the first layer 100. More specifically, the polarization filtering unit 20 is formed by passing through the portions adjacent to the corners of the second layer 100. The polarization filtering unit 20 includes a portion of the first polarization introducing path 21, interference protrusion 19 or interference preventive hole 19a.

[154] On the rear side of the second layer 150 is formed an upper portion of the first and

second guide units 31, 32, first relay unit 40 and first mixing unit 45 of the first polarization guide 30.

[155] Fig. 41 is a plan view of the third layer of Fig. 35, Fig. 42 is a perspective view of the third layer, and Fig. 43 is a rear view of the third layer.

[156] On the upper surface of the third layer 200 is formed a lower portion of the first polarization guide 30, while on the lower surface is formed only the polarization filtering unit 20 which is passed there through. Therefore, a lower portion of the first and second guide units 31, 32, first relay unit 40 and first mixing unit 45 of the first polarization guide 30 is formed on the upper surface of the third layer 200.

[157] Fig. 44 is a plan view of the fourth layer of Fig. 35, Fig. 45 is a perspective view of the fourth layer, and Fig. 46 is a rear view of the fourth layer.

[158] There is only the polarization filtering unit 20 passing through the upper surface of the fourth layer 250, and there is an upper portion of the first to fourth direction changing units 51, 52, 53, 54, third and fourth guide units 55, 60, second relay unit 63, and second mixing unit 65 formed on the lower surface of the fourth layer 250.

[159] Fig. 47 is a plan view of the fifth layer, and Fig. 48 is a perspective view of the fifth layer.

[160] On the upper surface of the fifth layer 300 is formed a lower portion of the second polarization guide 50. The fifth layer 300 forms the second polarization guide in cooperation with the fourth layer 250, and includes the first to fourth direction changing units 51, 52, 53, 54, third and fourth guide units 55, 60, second relay unit 63, and second mixing unit 65 formed thereon. Within the first to fourth direction changing units 51, 52, 53, 54 of the fifth layer 300, are formed the protruding ends 68 and the reflecting surfaces 69, respectively.

[161] Fig. 49 is a perspective view of the horn array antenna in use according to an embodiment of the present invention, Fig. 50 is a perspective view of the first layer, Fig. 51 is a plan view of the second layer, Fig. 52 is a perspective view of the second layer, and Fig. 53 is a rear view of the second layer.

[162] It is assumed that the horn array antenna 1 according to an embodiment of the present invention includes 8 horizontal horns and 16 vertical horns, which means the antenna 1 includes total 8 x 16 = 128 horns, in 32 antenna units including (4 x 8) horns. Accordingly, the second layer 150 according to this embodiment includes 128 horns 10 in total.

[163] The horn array antenna in operation according to an embodiment of the present invention will be explained layer by layer below.

[164] Fig. 54 is a plan view of the third layer of the horn array antenna of Fig. 49, Fig. 55 is a perspective view of the third layer, and Fig. 56 is a rear view of the third layer.

[165] The horn array antenna 1 according to this embodiment of the present invention includes 32 antenna units, in which the rear surface of the second layer 150 is engaged with the planar surface of the third layer 200 to thus form 32 first polarization guides 30.

[166] Accordingly, the first polarization is introduced into the horn 10, guided along the first polarization guide 30, output from the first polarization guide 30, mixed with the other first polarizations to form one stream of first polarization waves, and discharged out of the horn array antenna 1. To do this, a first polarization input and output hole 400 is formed between the first polarization guide-12 312 and the first polarization guide-13 313 on the lower surface of the third layer 200. Meanwhile, after being introduced into the first polarization input and output hole 40, the first polarization is split into the first polarization guides 30, respectively, and discharged out through the horns 10.

[167] The first polarization guide-1 301 and the first polarization guide-2 302 are in symmetric mirror image with each other, in which the first mixing unit 45 of the first polarization guide-1 301 and the first mixing unit 45 of the first polarization guide-2 302 are connected with each other for fluid communication by a first polarization split tube-1 351 which is formed in letter 'T' configuration.

[168] The first polarization guide-9 309 and the first polarization guide-10 310 are arranged parallel with the first polarization guide-1 301 and the first polarization guide-2 302, and the first mixing unit 45 of the first polarization guide-9 309 and the first mixing unit 45 of the first polarization guide-10 310 are connected with each other for fluid communication by the first polarization split tube-3 353. The first polarization split tube-1 351 and the first polarization split tube-3 353 are connected for fluid communication by the first polarization split tube-2 352. Accordingly, the first polarization coming from the first polarization-1 301, first polarization guide-2 302, first polarization guide-9 309, and first polarization guide-10 310 are mixed at the first polarization split tube-2 352.

[169] The first polarization guide-3 303 and the first polarization guide-4 304 are in symmetric mirror image with each other, and the first mixing unit 45 of the first polarization guide-3 303 and the first mixing unit 45 of the first polarization guide-4 304 are connected with each other for fluid communication by the first polarization split tube-5 355. The first polarization guide-11 311 and the first polarization guide-12 312

are arranged parallel with the first polarization guide-3 303 and the first polarization guide-4 304, and the first mixing unit 45 of the first polarization guide-11 311 and the first mixing unit 45 of the first polarization guide-12 312 are connected with each other for fluid communication by the first polarization split tube-7 357.

[170] The first polarization split tube-5 355 and the first polarization split tube-7 357 are connected with each other for fluid communication by the first polarization split tube-6 356. Accordingly, the first polarizations coming from the first polarization guide-3 303, first polarization guide-4 304, first polarization-11 311, and first polarization guide-12 312, are mixed with each other at the first polarization split tube-6 356.

[171] The first polarization split tube-2 352 and the first polarization split tube-6 356 are connected with each other by the first polarization split tube-4 354. If one and the other ends of the linear tube of the first polarization split tube-4 354 are port-2 and port-3, the first polarization guides-1, 2, 9, 10 (301, 302, 309, 310) are connected to port-2, while the first polarization guides-3, 4, 11, 12 (303, 304, 311, 312) are connected to port-3. In other words, the first polarization split tube-4 354 is the 1:1 splitter which has the same number of first polarization guides 30 connected to port-2 and port-3.

[172] Based on the above structure, the first polarizations coming from the first polarization guides-1, 2, 9, 10 (301, 302, 309, 310) and from the first polarization guides-3, 4, 11, 12 (303, 304, 311, 312) are mixed with each other at the first polarization split tube-4 354.

[173] The first polarization guide-5 305 and the first polarization guide-6 306 are in symmetry with each other, and the first mixing unit 45 of the first polarization guide-5 305 and the first mixing unit 45 of the first polarization guide-6 306 are connected with each other for fluid communication by the first polarization split tube-8 358. The first polarization guide-13 313 and the first polarization guide-14 314 are arranged parallel with the first polarization guide-5 305 and the first polarization guide-6 306, and the first mixing unit 45 of the first polarization guide-13 313 and the first mixing unit 45 of the first polarization guide-13 314 are connected with each other for fluid communication by the first polarization split tube-10 360.

[174] The first polarization split tube-8 358 and the first polarization split tube-10 310 are connected with each other for fluid communication by the first polarization split tube-9 359. Accordingly, the first polarizations coming from the first polarization guides-5, 6, 13, 14 (305, 306, 313, 314) are mixed with each other at the first polarization split tube-9 359.

[175] The first polarization guide-7 307 and the first polarization guide-8 308 are in

symmetry with each other, and the first mixing unit 45 of the first polarization guide-7 307 and the first mixing unit 45 of the first polarization guide-8 308 are connected with each other for fluid communication by the first polarization split tube-12 362. The first polarization guide-15 315 and the first polarization guide-16 316 are arranged parallel with the first polarization guide-7 307 and the first polarization guide-8 308, and the first mixing unit 45 of the first polarization guide-15 315 and the first mixing unit 45 of the first polarization guide-16 316 are connected with each other for fluid communication by the first polarization split tube-14 364. The first polarization split tube-12 362 and the first polarization split tube-14 364 are connected with each other for fluid communication by the first polarization split tube-13 363. Accordingly, the first polarizations coming from the first polarization guides-7, 8, 15, 16 (307, 308, 315, 316) are mixed with each other at the first polarization split tube-13 363.

[176] The first polarization split tube-9 359 and the first polarization split tube-13 363 are connected with each other by the first polarization split tube-11 361, and the first polarization guides-5, 6, 13, 14 (305, 306, 313, 314) are connected to port-2, and the first polarization guides-7, 8, 15, 16 (307, 308, 315, 316) are connected to port-3 of the first polarization split tube-11 361. In other words, the first polarization split tube-11 361 is the 1:1 splitter which has the same number of first polarization guides 30 connected to port-2 and port-3.

[177] Based on the above structure, the first polarizations coming from the first polarization guides-5, 6, 13, 14 (305, 306, 313, 314) and from the first polarization guides-7, 8, 15, 16 (307, 308, 315, 316) are mixed with each other at the first polarization split tube-11 361.

[178] Although these will be explained in detail below, the first polarization guides-17 to 32 will first be explained briefly since these have the same arrangement as the first polarization guides-1 to 16.

[179] The first polarization guide-17 317 and the first polarization guide-18 318 are connected with each other by the first polarization split tube-15 365, and the first polarization guide-25 325 and the first polarization guide-26 326 are connected with each other by the first polarization split tube-17 367. The first polarization split tube-15 365 and the first polarization split tube-17 367 are connected with each other for fluid communication by the first polarization split tube-16 366. The first polarization guide-19 319 and the first polarization guide-20 320 are connected with each other by the first polarization split tube-19 369, and the first polarization guide-27 327 and the first polarization guide-28 328 are connected with each other by the first polarization split

tube-21 371. The first polarization split tube-19 369 and the first polarization split tube-21 371 are connected with each other for fluid communication by the first polarization split tube-20 370.

[180] The first polarization split tube-16 366 and the first polarization split tube-20 370 are connected with each other by the first polarization split tube-18 368, and the first polarization guides-19, 20, 27, 28 (319, 320, 327, 328) are connected to port-2, and the first polarization guides-17, 18, 25, 26 (317, 318, 325, 326) are connected to port-3 of the first polarization split tube-18 368. In other words, the first polarization split tube-18 368 is the 1:1 splitter which has the same number of first polarization guides 30 connected to port-2 and port-3.

[181] The first polarization guide-21 321 and the first polarization guide-22 322 are connected with each other by the first polarization split tube-22 372, and the first polarization guide-29 329 and the first polarization guide-30 330 are connected with each other by the first polarization split tube-24 374. The first polarization split tube-22 372 and the first polarization split tube-24 374 are connected with each other for fluid communication by the first polarization split tube-23 373. The first polarization guide-23 323 and the first polarization guide-24 324 are connected with each other by the first polarization split tube-26 376, and the first polarization guide-31 331 and the first polarization guide-32 332 are connected with each other by the first polarization split tube-28 378. The first polarization split tube-26 376 and the first polarization split tube-28 378 are connected with each other for fluid communication by the first polarization split tube-27 377.

[182] The first polarization split tube-23 373 and the first polarization split tube-27 388 are connected with each other by the first polarization split tube-25 375, and the first polarization guides-23, 24, 31, 32 (323, 324, 331, 332) are connected to port-2, and the first polarization guides-21, 22, 29, 30 (321, 322, 329, 330) are connected to port-3 of the first polarization split tube-18 368. In other words, the first polarization split tube-25 375 is the 1:1 splitter which has the same number of first polarization guides 30 connected to port-2 and port-3.

[183] Accordingly, the first polarizations coming from the first polarization guides-17, 18, 25, 26 (305, 306, 313, 314) and from the first polarization guides-19, 20, 27, 28 (319, 320, 327, 328) are mixed with each other at the first polarization split tube-18 368, and the first polarizations coming from the first polarization guides-21, 22, 29, 30 (321, 322, 329, 330) and from the first polarization guides-23, 24, 31, 32 (323, 324, 331, 332) are mixed with each other at the first polarization split tube-25 375.

[184] Meanwhile, the first polarization split tube-4 354 and the first polarization split tube-18 368 are connected to port-3 and port-2 of the first polarization split-tube-29 379, and the first polarization coming from the first polarization split tube-4 354 and the first polarization coming from the first polarization split tube-18 368 are mixed with each other at the first polarization split tube-29 379.

[185] The first polarization split tube-11 361 and the first polarization split tube-25 375 are connected to port-2 and port-3 of the first polarization split tube-30 380 for fluid communication with each other, and the first polarizations from the first polarization split tube-11 361 and the first polarization split tube-25 375 are mixed at the first polarization split tube-30 380. The first polarization split tube-29 379 and the first polarization split tube-30 380 are connected to port-3 and port-2 of the first polarization split tube-31 381 for fluid communication with each other, and there is a first polarization input and output hole 400 formed in port-1 of the first polarization split tube-31 381. Accordingly, the first polarizations coming from the first polarization split tube-29 379 and the first polarization split tube-30 380 are mixed with each other at the first polarization split tube-31 381, moved forward, and discharged outside through the first polarization input and output hole 400.

[186] The first polarization split tubes-1 to 31 (351-381) each have the same number of first polarization guides 30 that are connected to ports-2 and ports-3. In other words, the first polarization split tubes-1 to 31 (351-381) are the 1:1 splitters. The first polarization split tubes-1 to 31 (351-381) may have different configurations according to their positions.

[187] Fig. 57 is a plan view of the fourth layer of Fig. 49, Fig. 58 is a perspective view of the fourth layer, and Fig. 59 is a rear view of the fourth layer.

[188] The fourth layer 250 forms the second polarization guide 50 in cooperation with the fifth layer 300, and accordingly, an upper portion of 32 second polarization guides 50 is formed on the rear surface of the fourth layer 250. A first polarization input and output hole 400 is formed on the fourth layer 250 to guide the first polarization entering or exiting the first polarization guide 30.

[189] Fig. 60 is a front view of the fifth layer of Fig. 49, Fig. 61 is a perspective view of the fifth layer, and Fig. 62 is a rear view of the fifth layer.

[190] On the front surface of the fifth layer 300 is formed a lower portion of the second polarization guide 50, and on the rear surface of the fifth layer 300 is formed a second polarization input and output hole 600 to guide the second polarization entering or exiting the second polarization guide 50.

[191] The second polarization guide-1 501 and the second polarization guide-9 509 are in symmetric mirror image with each other, and the second mixing unit 65 of the second polarization guide-1 501 and the second mixing unit 65 of the second polarization guide-9 509 are connected with each other for fluid communication by the second polarization split tube-1 551 which is formed in letter 'T' configuration.

[192] The second polarization guide-2 502 and the second polarization guide-10 510 are arranged parallel with respect to the second polarization guide-1 501 and the second polarization guide-9 509, and the second mixing unit 65 of the second polarization guide-2 502 and the second mixing unit 65 of the second polarization guide-10 510 are connected with each other for fluid communication by the second polarization split tube-3 553. The second polarization split tube-1 551 and the second polarization split tube-3 553 are connected with each other for fluid communication by the second polarization split tube-2 552.

[193] The second polarization guide-3 503 and the second polarization guide-11 511 are in symmetry with each other, and the second mixing unit 65 of the second polarization guide-3 503 and the second mixing unit 65 of the second polarization guide-11 511 are connected with each other for fluid communication by the second polarization split tube-4 554. The second polarization guide-4 504 and the second polarization guide-12 512 are arranged parallel with respect to the second polarization guide-3 503 and the second polarization guide-11 511, and the second mixing unit 65 of the second polarization guide-4 504 and the second mixing unit 65 of the second polarization guide-12 512 are connected with each other for fluid communication by the second polarization split tube-6 556. The second polarization split tube-4 554 and the second polarization split tube-6 556 are connected with each other for fluid communication by the second polarization split tube-5 555.

[194] The second polarization guide-17 517 and the second polarization guide-25 525 are in symmetry with each other, and the second mixing unit 65 of the second polarization guide-17 517 and the second mixing unit 65 of the second polarization guide-25 525 are connected with each other for fluid communication by the second polarization split tube-19 569. The second polarization guide-18 518 and the second polarization guide-26 526 are arranged parallel with respect to the second polarization guide-17 517 and the second polarization guide-25 525, and the second mixing unit 65 of the second polarization guide-18 518 and the second mixing unit 65 of the second polarization guide-26 526 are connected with each other for fluid communication by the second polarization split tube-21 571. The second polarization split tube-19 569 and the second

polarization split tube-21 571 are connected with each other for fluid communication by the second polarization split tube-20 570.

[195] The second polarization guide-19 519 and the second polarization guide-27 527 are in symmetry with each other, and the second mixing unit 65 of the second polarization guide-19 519 and the second mixing unit 65 of the second polarization guide-27 527 are connected with each other for fluid communication by the second polarization split tube-22 572. The second polarization guide-20 520 and the second polarization guide-28 528 are arranged parallel with respect to the second polarization guide-19 519 and the second polarization guide-27 527, and the second mixing unit 65 of the second polarization guide-20 520 and the second mixing unit 65 of the second polarization guide-28 528 are connected with each other for fluid communication by the second polarization split tube-24 574. The second polarization split tube-22 572 and the second polarization split tube-24 574 are connected with each other for fluid communication by the second polarization split tube-23 573.

[196] The second polarization split tube-2 552 and the second polarization split tube-10 560 are connected with each other by the second polarization split tube-13 563, and if one and the other ends of the second polarization split tube-13 563 are port-2 and port-3, there are second polarization guides-17, 18, 25, 26 (517, 518, 525, 526) connected to port-2, while there are second polarization guides-1, 2, 9, 10 (501, 501, 509, 510) connected to port-3. In other words, the second polarization split tube-13 563 is the 1:1 splitter that has the same number of second polarization guides 50 connected to port-2 and port-3, respectively.

[197] Likewise, the second polarization split tube-5 555 and the second polarization split tube-23 573 are connected with each other by the second polarization split tube-15 565, and the second polarization guides-3, 4, 11, 12 (503, 504, 511, 512) are connected to port-2, while there are second polarization guides-19, 20, 27, 28 (519, 520, 527, 528) connected to port-3 of the second polarization split tube-15 565. In other words, the second polarization split tube-15 565 is the 1:1 splitter that has the same number of second polarization guides 50 connected to port-2 and port-3, respectively.

[198] The second polarization guide-5 505 and the second polarization guide-13 513 are connected with each other by the second polarization split tube-7 557, and the second polarization guide-6 506 and the second polarization guide-14 514 are connected with each other by the second polarization split tube-9 559. The second polarization split tube-7 557 and the second polarization split tube-9 559 are connected with each other for fluid communication by the second polarization split tube-8 558. The second po-

larization guide-7 507 and the second polarization guide-15 515 are connected with each other by the second polarization split tube-10 560, and the second polarization guide-8 508 and the second polarization guide-16 516 are connected with each other by the second polarization split tube-12 562. The second polarization split tube-10 560 and the second polarization split tube-12 562 are connected with each other for fluid communication by the second polarization split tube-11 561.

[199] The second polarization guide-21 521 and the second polarization guide-29 529 are connected with each other by the second polarization split tube-25 575, and the second polarization guide-22 522 and the second polarization guide-30 530 are connected with each other by the second polarization split tube-27 577. The second polarization split tube-25 575 and the second polarization split tube-27 577 are connected with each other for fluid communication by the second polarization split tube-26 576. The second polarization guide-23 523 and the second polarization guide-31 531 are connected with each other by the second polarization split tube-28 578, and the second polarization guide-24 524 and the second polarization guide-32 532 are connected with each other by the second polarization split tube-30 580. The second polarization split tube-28 578 and the second polarization split tube-30 580 are connected with each other for fluid communication by the second polarization split tube-29 579.

[200] The second polarization split tube-8 558 and the second polarization split tube-26 576 are connected with each other by the second polarization split tube-16 566, and the second polarization guides-21, 22, 29, 30 (521, 522, 529, 530) are connected to port-2, while there are second polarization guides-5, 6, 13, 14 (505, 506, 513, 514) connected to port-3 of the second polarization split tube-16 566. In other words, the second polarization split tube-16 566 is the 1:1 splitter that has the same number of second polarization guides 50 connected to port-2 and port-3, respectively.

[201] Likewise, the second polarization split tube-11 561 and the second polarization split tube-29 579 are connected with each other by the second polarization split tube-18 568, and the second polarization guides-7, 8, 15, 16 (507, 508, 515, 516) are connected to port-2, while there are second polarization guides-23, 24, 31, 32 (523, 524, 531, 532) connected to port-3 of the second polarization split tube-18 568. In other words, the second polarization split tube-18 568 is the 1:1 splitter that has the same number of second polarization guides 50 connected to port-2 and port-3, respectively.

[202] The second polarization split tube-13 563 and the second polarization split tube-15 565 are connected to port-2 and port-3 of the second polarization split tube-14 564, and thus are connected with each other for fluid communication, and the second po-

larization split tube-16 566 and the second polarization split tube-18 568 are connected to port-2 and port-3 of the second polarization split tube-17 567, and thus are connected with each other for fluid communication.

[203] Port-1 of the second polarization split tube-14 564 extends in between the second polarization guide-18 518 and the second polarization guide-19 519, and is bent at the outer side of the second polarization guide-27 527 toward the second polarization guide-28 528, and port-1 of the second polarization split tube-17 567 extends in between the second polarization guide-22 522 and the second polarization guide-23 523, and is bent at the outer side of the second polarization guide-30 530 toward the second polarization guide-29 529. The second polarization split tube-14 564 as bent and the second polarization split tube-17 567 as bent, are connected to port-3 and port-2 of the second polarization split tube-31, respectively. The second polarization split tube-31 has the second polarization input and output hole 600 formed on its port-1 for the entering and exiting of the second polarization.

[204] The process in which the second polarization moves along the second polarization guide 50 and exits through the second polarization input and output hole 600 in the horn array antenna for dual linear polarization constructed as explained above according to the embodiments of the present invention will be explained below briefly.

[205] The second polarizations coming from the second polarization guides-1, 2, 9, 10 (501, 502, 509, 510) and second polarization guides-17, 18, 25, 26 (517, 518, 525, 526), are mixed at the second polarization split tube-13 563, and the second polarizations coming from the second polarization guides-3, 4, 11, 12 (503, 504, 511, 512) and second polarization guides-19, 20, 27, 28 (519, 520, 527, 528), are mixed at the second polarization split tube-15 565. The second polarizations coming from the second polarization split tube-13 563 and the second polarization split tube-15 565, are mixed at the second polarization split tube-14 564.

[206] Likewise, the second polarizations coming from the second polarization guides-5, 6, 13, 14 (505, 506, 513, 514) and second polarization guides-21, 22, 29, 30 (521, 522, 529, 530), are mixed at the second polarization split tube-16 566, and the second polarizations coming from the second polarization guides-7, 8, 15, 16 (507, 508, 515, 516) and second polarization guides-23, 24, 31, 32 (523, 524, 531, 532), are mixed at the second polarization split tube-18 568. The second polarizations coming from the second polarization split tube-16 566 and the second polarization split tube-18 568, are mixed at the second polarization split tube-17 567.

[207] Meanwhile, the second polarizations coming from the second polarization split tube-

14 564 and the second polarization split tube-17 567, are mixed with each other at the second polarization split tube-31 581 and exits through the second polarization input and output hole 600.

[208] Each of the second polarization split tubes-1 to 31 (551-581) are the 1:1 splitters, in which the same number of second polarization guides 50 are connected to port-2 and port-3, respectively. The second polarization split tubes-1 to 31 (551-581) may have different configurations according to their positions.

[209] Figs. 63 and 64 are plan views illustrating the 1:1 splitters according to embodiments of the present invention.

[210] The first polarization split tubes-1 to 31 (351-381), and the second polarization split tubes-1 to 31 (551-581) may be constructed using 1:1 splitters.

[211] Referring to Fig. 63, and according to one embodiment of the present invention, a 1:1 splitter 700 may include a linear tube 710 which is connected to the first polarization guide 30 or the second polarization guide 50, and which includes port-1 or port-2, and a branch tube 720 which extends from the middle portion of the linear tube 710 and which has port-3.

[212] The linear tube 710 has a plurality of steps 705 to gradually decrease the width of the linear tube 710 toward the middle portion. The steps 705 are formed on a wall connected to the branch tube 720 of the linear tube 710. The number of steps 705, or intervals therebetween may vary according to the frequency of the first or second polarization, and the steps 705 may be formed on a wall facing the branch tube 720 of the linear tube 710. The linear tube 710 also includes a split protrusion 707 protruding inward from the middle portion of the linear tube 710, that is, protruding from a wall that faces the branch tube 720.

[213] Referring to Fig. 64, and according to another embodiment of the present invention, a 1:1 splitter 750 may be formed in letter 'T' configuration having a linear tube 760 and a branch tube 770. The linear tube 760 includes port-1 and port-2, and has a width gradually increasing toward the middle portion thereof. To achieve this, there is a recess 755 formed in the linear tube 760, on a wall that faces the branch tube 770. The number or depth of recess 755 may vary according to the frequency of the first or second polarization, and the recess 755 may be formed on a wall facing the branch tube 770 of the linear tube 760. The recess 755 includes a protrusion 757 protruding from the middle portion toward the branch tube 770.

[214] Figs. 65 to 67 are plan views illustrating m:n splitters according to embodiments of the present invention.

[215] The first polarization split tubes-1 to 31 (351-381), and the second polarization split tubes-1 to 31 (551-581) may be constructed using m:n splitters.

[216] Referring to Fig. 65, and according to one embodiment of the present invention, a m:n splitter 800 may include a linear tube 810 connecting port-2 and port-3, and a branch tube 820 having port-1. Ports 1 to 3 have the identical width. The linear tube 810 includes a plurality of steps 805 to gradually decrease the width of the linear tube 810 from port-2 and port-3 toward the middle portion. The steps 805 on the side of port-2 may have slightly increasing length toward the middle portion of the linear tube 810, or alternatively, the steps 805 may have almost the same length. On the other hand, there is a mixture of short and long steps on the side of port-3. These steps 805 of the linear tube 810, which are formed on a wall connected to the branch tube 820, may alternatively be formed on a wall that faces the branch tube 820. On the middle portion of the linear tube 810, there is an asymmetric protrusion 807 extending from a wall facing the branch tube 820 toward the branch tube 820. The asymmetric protrusion 807 may consist of square and triangular columns, and may be formed adjacent to port-2.

[217] Referring to Fig. 66, and according to a second embodiment of the present invention, a m:n splitter 850 may include a linear tube 860 connecting port-2 and port-3, and a branch tube 870 having port-1. Port-2 and port-3 have the identical width, and port-1 has a width two times larger than that of port-2 and port-3. The linear tube 860 includes a plurality of steps 855 to gradually decrease the width of the linear tube 860 from port-2 and port-3 toward the middle portion. There is a mixture of short and long steps 855 on the side of port-2, and relatively longer steps 855 are formed on the side of port-3. These steps 855 of the linear tube 860, which are formed on a wall connected to the branch tube 870, may alternatively be formed on a wall that faces the branch tube 870. As in the first embodiment, there is an asymmetric protrusion 857 extending from a wall facing the branch tube 870.

[218] Referring to Fig. 67, and according to a third embodiment of the present invention, a m:n splitter 900 may include a linear tube 910 connecting port-2 and port-3, and a branch tube 920 having port-1. Port-2 and port-3 have the identical width, and port-1 has a width two times larger than that of port-2 and port-3. The linear tube 910 includes a split protrusion 907 extending from the middle portion toward the branch tube 920.

[219] In the above horn array antenna 1 for dual linear polarization according to the embodiments of the present invention, most of the antennas employ the m:n splitter, while

there is almost the same amount of first or second polarization that goes into the first polarization split tubes-1 to 31 (351-381) and the second polarization split tubes-1 to 31 (551-581). This is done so in order to cover the situation when the antenna needs to have certain directivity, in which case the first or second polarization is radiated in an inclined pattern. One will note that the antennas illustrated in the accompanying drawings are the examples of the present invention, and that not only the 1:1 splitter illustrated in Figs. 63 and 64, but also the m:n splitters illustrated in Figs. 65 to 67 can be adequately employed according to use and performance of the antennas.

[220] Accordingly, the horn array antenna 1 for dual linear polarization according to the embodiments of the present invention can the horns 10 of reduced height, without compromising the efficiency of the antenna 1, by forming the first and second protrusions 17, 18 on the horns 10. Furthermore, since the first and second polarization guides 30, 50 have longer horizontal width than height, the lateral size of the antenna can also be reduced.

[221] Although the size of the antenna 1 is reduced, Table 1 above shows that the antenna 1 still have uncompromised performance. Furthermore, the horn array antenna 1 for dual linear polarization according to the embodiments of the present invention has the first and second polarization guides 30, 50 of the uniform heights, and is thus easy to fabricate.

[222] Although the first and second polarizations have been explained with reference to electric field in the above embodiments, one will understand that these are applicable to the magnetic field too. Furthermore, the embodiments above are only for illustrative purposes to explain the process of fabricating the horns 10, first polarization guides 30, and second polarization guides 50, and should not be construed as limiting. For example, if necessary, two or more of the horns 10, first polarization guides 30, and second polarization guides 50, may be fabricated at once, using proper methods such as injection molding. Furthermore, the number of layers to fabricate the horns 10, first polarization guides 30, and second polarization guides 50 is not limited to the examples illustrated in Figs. 38 to 62.

[223] In order to improve the receptivity of the second polarization at the horn array antenna 1 for dual linear polarization according to the embodiments of the present invention, referring to Fig. 68, the second polarization entering the antenna 1 needs to have a direction of electric field parallel to a shorter lower side of the polarization filtering unit 20. Referring to Fig. 69, if the second polarization entering has the direction of electric field that is not parallel to the shorter lower sides of the po-

larization filtering unit 20, the horn array antenna 1 for dual linear polarization has bad receptivity of second polarization.

[224] However, the receptivity of second polarization may still be good even when the second polarization entering has the direction of electric field that is inclined, rather than parallel to the shorter lower sides of the polarization filtering unit 20. That is, referring to Fig. 70, there is a comb-pattern skew filter provided to the horn array antenna 1 for dual linear polarization, and this causes the direction of electric field of the second polarization to rotate to parallel relation with the shorter lower sides of the polarization filtering unit 20.

[225] The comb pattern of the skew filter may desirably be vertical to the direction of electric field of the second polarization entering. This is because the direction of the second polarization is rotated as much as the angle of the teeth of the skew filter. Referring again to Fig. 70, the teeth of the skew filter are inclined at approximately 30°. Accordingly, the direction of the second polarization which is entering at 30°of inclination from the shorter lower sides of the polarization filtering unit 20, rotates by 30°according to the angle of the teeth of the skew filter, to enter the polarization filtering unit 20 in parallel relation with the shorter lower sides (that is, the direction of electric field of the second polarization illustrated in Fig. 68).

[226] Meanwhile, the angle of incidence of the second polarization is different depending on the location (latitude and longitude) of the area where the horn array antenna 1 is used, and this means that the angle of incidence of the second polarization can be computed based on the latitude and longitude of the location to receive the second polarization. Accordingly, based on the latitude and longitude of the area to receive the second polarization, the angle of teeth of the skew filter can be decided.

[227] The skew filter may be embodied using conductive materials such as copper, nickel, or iron, or alternatively, the skew filter may desirably be embodied by plating synthetic resin with an adequate conductive material. The skew filter may preferably have 0.03mm to 1mm of thickness, but this may vary as occasion demands.

[228] Figs. 71 to 78 illustrate a method for applying a skew filter to the horn array antenna for dual linear polarization according to embodiments of the present invention.

[229] Referring to Fig. 71, a skew filter provided as a film may be placed on the upper portion of the first layer 100. Secondly, referring to Fig. 72, a skew filter may be formed directly on the upper portion of the first layer 100.

[230] According to the abovementioned first and second methods, the skew filter is formed on the upper portion of the horns 10. The ends of the teeth of the skew filter are in

contact with the edge of the outer opening of the horns 10. Accordingly, it is possible to change the direction of all the second polarization entering the outer openings.

[231] Thirdly, and referring to Fig. 73, a film type of skew filter may be inserted between the first and second layers 100, 150. Fourthly, and referring to Fig. 74, a skew filter may be formed directly on the upper portion of the second layer 150.

[232] According to the third and fourth methods explained above, the skew filter is formed on the lower side of the horns 10. The ends of the teeth of the skew filter are in contact with the lower edge of the horns 10. Accordingly, it is possible to change the direction of all the second polarizations entering the lower side of the horns 10.

[233] Meanwhile, a skew filter according to the first to fourth methods can be designed to change the direction of the first polarization. In order to rotate the direction of the first polarization, the teeth of the skew filter need to be perpendicular to the direction of the entering first polarization.

[234] Referring to Fig. 75, the fifth method is to insert a film type skew filter in between the second and third layers 150, 200. Referring to Fig. 76, the sixth method is to form a skew filter directly on the upper portion of the third layer 200.

[235] According to the fifth and sixth methods explained above, the skew filter is formed in the center of the polarization filtering unit 20. The ends of the teeth of the skew filter are in contact with the walls of the polarization filtering unit 20. Accordingly, it is possible to change the direction of all the entering second polarization.

[236] Referring to Fig. 77, the seventh method is to insert a film type skew filter in between the third and fourth layers 200, 250. Referring to Fig. 78, the eighth method is to form the skew filter directly on the upper portion of the fourth layer 250.

[237] According to the seventh and eighth methods explained above, the skew filter is formed on the lower portion of the polarization filtering unit 20. The ends of the teeth of the skew filter are in contact with the walls of the polarization filtering unit 20. Accordingly, it is possible to change the direction of all the entering second polarization.

[238] The number of teeth of the skew is not limited, and therefore, one or more than one teeth may be formed as occasion demands. Furthermore, the width of the tooth, and the intervals between the teeth are not limited. The ends of the teeth may desirably be rounded. Refer to Figs. 79 to 83 for variations of the skew filter.

[239] It is possible that the ends of the teeth of the skew filter are not in contact with the horns 10 or polarization filtering units 20. The ends of the teeth may also be rounded. Figs. 84 to 86 illustrate skew filters whose ends are not in contact with the walls of the polarization filtering units 20. The skew filters illustrated have one tooth, but one will

understand that two or more teeth may be employed.

[240] Note that only the film type skew filter can have ends of the teeth that do not contact the polarization filtering units 20, and it is necessary to coat the skew filter as a thin layer of nonconductive material to fix the teeth in position.

[241] The teeth of the skew filter may be formed in various manners other than the examples provided above.

[242] In the horn array antenna 1 for dual linear polarization explained above according to the embodiments of the present invention, the polarization filtering units 10 are parallel to the horns 10 (that is, the sides of the polarization filtering units 20 are parallel to the sides of the horns 10). However, even when the polarization filtering units 20 and the horns 10 are not parallel, for example, even when the sides of the polarization filtering units 20 are at 45° with respect to the sides of the horns 10 (Fig. 87), it is still possible to employ the skew filter according to the embodiments of the present invention.

[243] Furthermore, although the process of the horn array antenna for dual linear polarization receiving the polarization has been explained so far, one will understand that the same applies to the case of transmitting the polarization so that it is possible to use the skew filter to transmit the polarization having certain degrees of inclination.

[244] Two overlaying skew filters may be used, and a spacer may be inserted between the horn array antenna and the skew filter or between the skew filters to provide a space there between.

[245] The spacer may be made of, for example, paper, woodrock, or thin sponge plate. The spacer may not be made of a material that disturbs electric waves, since the spacer is inserted between the horn array antenna and the skew filter or between the skew filters to provide, for example, a few millimeters of space. For example, a material with high conductivity is not a good choice for the spacer.

[246] The spacer may have a predetermined height (such as a few millimeters) as illustrated in Fig. 88 or Fig. 89, and be provided in a square configuration. The vertical and horizontal sides of the square may desirably correspond to the skew filter, but this is not limiting, since the spacer can have any structure if it provides a space between the skew filter and the horn array antenna for dual linear polarization.

[247] Referring to Fig. 88, a spacer 441 is s square spacer to correspond to the structure of the skew filter. The spacer 44 does not necessarily have the same vertical and horizontal lengths as those of the skew filter, since the spacer is fully satisfactory if it provides a space between the skew filter and the horn array antenna.

[248] Referring to Fig. 89, a spacer 443 is an empty square spacer. An additional structure such as the one similar to a window frame may be provided in the empty space of the spacer 443.

[249] The spacers explained above can be placed between the skew filter and the horn array antenna, or between the skew filters.

[250] Although the horn array antenna for dual linear polarization having a skew filter has been explained above, one will note that the skew filter can be fabricated separately.

[251] Herein below, a horn array antenna for single linear polarization applicable to the embodiments of the present invention will be explained in detail. Although the applicable horn array antenna for single linear polarization is capable of both transmitting and receiving the electromagnetic waves, for convenience of explanation, the operations of each component part of the horn array antenna will be focused mainly on the receiving end, and then the operations of the horn array antenna as a transmitting end will be explained in the later part of the description.

[252] The horn array antenna for single linear polarization is capable of transmitting or receiving both horizontal (H) and vertical (V) polarizations.

[253] Fig. 90 is a perspective view of a horn array antenna for single linear polarization applicable to the embodiments of the present invention, and Fig. 91 is an exploded perspective view illustrating the layers of the horn array antenna of Fig. 90.

[254] As shown, the horn array antenna 10 for single linear polarization includes three layers 310, 320, 330 overlain on one another. The horn array antenna 10 includes four horns 100 to which electromagnetic waves enter, and a guide 200 to form the electromagnetic waves into a single stream and outputs the electromagnetic waves.

[255] Each of the horns 100 is the place where an outer opening 110, an inclined portion 120, a protrusion 130, and an inner opening 140 are formed.

[256] The protrusion 130 extends inward from the outer side of the horn 100. Due to the presence of the protrusion 130, the area of the inner opening 140 is smaller than that of the outer opening 110.

[257] The inclined portion 120 is inclined inward at the outer side of the horn 100, with reference to the downward direction of the horn 100.

[258] While the outer opening 110 is square shape, the inner opening 140 is rectangular shape. Accordingly, two types of linear polarizations enter the outer opening 110, but only the linear polarization having the direction of electric field that is parallel to the shorter sides of the inner opening 140, can pass to enter the inner opening 140.

[259] The horn 100 is formed over the first and second layers 310, 320. Specifically, the

upper portion of the horn 100 is formed on the first layer 310, while there is the lower portion of the horn 100 formed on the upper portion of the second layer 320. The upper portion of the horn 100 corresponds to the outer opening 110 and the inclined portion 120, and the lower portion of the horn 100 corresponds to the protrusion 130 and the inner opening 140.

[260] The guide 200 is formed over the second and third layers 320, 330. Specifically, an upper portion of the guide 200 is formed on the lower portion of the second layer 320, while there is the lower portion of the guide 200 formed on the third layer 330.

[261] Fig. 92 is a perspective view of the first layer 310, Fig. 93 is a plan view of the first layer 310 viewed from above, and Fig. 94 is a rear view of the first layer 310 viewed from under.

[262] As shown, the outer opening 110 of the horn 100 is formed on the planar side of the first layer 310. There also is an opening in the rear side of the first layer 310.

[263] Due to the inclined portion 120 formed on the first layer 310, the area of the outer opening 110 formed on the planar side is larger than that of the opening formed on the rear side.

[264] Fig. 95 is a perspective view of the second layer 320, Fig. 96 is a plan view of the second layer 320 viewed from above, and Fig. 97 is a rear view of the second layer 320 viewed from under.

[265] As explained above, the lower portion of the horn 100 and the upper portion of the guide 200 are formed on the second layer 320. Referring to Fig. 96, there is an opening formed on a planar side of the second layer 320 (that is, on the upper portion of the second layer 320), which corresponds to the inner opening 140 of the horn 100. The area of the inner opening 140 formed on the second layer 320 is smaller than that of the opening formed on the rear side of the first layer 310. As a result, the protrusion 130 is formed as illustrated in Fig. 90.

[266] Referring to Fig. 97, on the rear side of the second layer 320 is formed the upper portion of the guide 200.

[267] Fig. 98 is a perspective view of the third layer 330, Fig. 99 is a plan view of the third layer 330 viewed from above, and Fig. 100 is a rear view of the third layer 330 viewed from under.

[268] As shown, the lower portion of the guide 200 is formed on the planar side of the third layer 330, including: 1) four direction changing units 211, 212, 213, 214 to change the advancing direction of the electric waves entering the four horns 100; 2) first guide tube 241 to connect the first and second direction changing units 211, 212; 3) a second

guide tube 242 to connect the third and fourth direction changing units 213, 214; 4) a relay tube 260 to connect the first and second guide tubes 241, 242; and 5) a mixing tube 280 to mix the electromagnetic waves transferred from the first and second guide tubes 241, 242 via the relay tube 260 and output the waves.

[269] The direction changing units 211, 212, 213, 214 include protruding ends 221, 222, 223, 224, and reflecting surfaces 231, 232, 233, 234. Each of the protruding ends 221, 222, 223, 224 extends upward from the bottom of one side of the direction changing unit 211, 212, 213, 214. As the electromagnetic waves entering through the horns 100 hit the protruding ends 221, 222, 223, 224, the waves change direction to face the reflecting surfaces 231, 232, 233, 234.

[270] The reflecting surfaces 231, 232, 233, 234 are formed as triangular columns, on the surfaces of the direction changing units 211, 212, 213, 213 that face the surfaces on which the protruding ends 221, 222, 223, 224 are formed. The reflecting surfaces 231, 232, 233, 234 reflect the electromagnetic waves whose direction is changed due to the protruding ends 221, 222, 223, 224, so that the electromagnetic waves enter into the guide tubes 241, 242.

[271] The first protruding end 221 and the first reflecting surface 231 of the first direction changing unit 211 are in symmetric mirror image with the second protruding end 222 and the second reflecting surface 232 of the second direction changing unit 212. The third protruding end 223 and the third reflecting surface 233 of the third direction changing unit 213 are in symmetric mirror image with the fourth protruding end 224 and the fourth reflecting surface 234 of the fourth direction changing unit 214.

[272] The first guide tube 241 mixes the electromagnetic waves, which changed direction of movement at the first and second direction changing units 211, 212, and provides the electromagnetic waves to the relay tube 260. The second guide tube 242 mixes the electromagnetic waves, which changed direction of movement at the third and fourth direction changing units 213, 214, and provides the electromagnetic waves to the relay tube 260. The first and second guide tubes 241, 242 are in symmetry with the relay tube 260.

[273] The first guide tube 241 includes a step 251. Accordingly, one and the other ends of the first guide tube 241, which are connected to the first and second direction changing units 211, 212, have wider widths than that of the middle portion. One single step 251 or more than one steps 251 may be formed.

[274] Likewise, the second guide tube 242 includes a step 252. Accordingly, one and the other ends of the second guide tube 242, which are connected to the third and fourth

direction changing units 213, 214, have wider widths than that of the middle portion. One single step 252 or more than one steps 252 may be formed.

[275] The first and second guide tubes 241, 242 are connected with each other by the relay tube 260 by their middle portions. The relay tube 260 is a linear tube, which has a narrow width in the middle portion than in one and the other ends. To achieve this, the relay tube 260 includes a protruding portion 270 extending inward by a predetermined length from a wall connected to the mixing tube 280.

[276] Although the protruding portion 270 is formed on a wall that is connected to the mixing tube 280, this is not limited. For example, the protruding portion 270 may be formed on the opposite wall. Furthermore, more than one protruding portion 270 may be formed with various lengths. Therefore, it is possible to adjust the frequency of the electromagnetic waves mixed at the mixing tube 280, by adjusting the number, length, and width of the protruding portions 270.

[277] The mixing tube 280 extends from the middle portion of the relay tube 260, bent once to parallel relation with the relay tube 260, and bent again to form a right angle with the relay tube 260.

[278] A slant surface is formed on the outer edge of the first bent of the mixing tube to change the advancing direction of the electromagnetic waves, and another slant surface 292 is formed on the outer edge of the second bent to change the advancing direction of the electromagnetic waves.

[279] Accordingly, the electromagnetic waves entering through the relay tube 260 are mixed at the mixing tube 280, change the direction due to the slant surfaces 291, 292, and exit.

[280] The process of the horn array antenna 10 for single linear polarization receiving the electromagnetic waves will be explained below.

[281] Electromagnetic waves enter into the outer opening 110 of the horn 100, and guided along the inclined portion 120. The linear polarization having the direction of electric field that is same as the wider width of the inner opening 140, does not pass the inner opening 140, while the linear polarization having the direction of electric field that is same as the narrower width of the inner opening 140 - the width is reduced due to the presence of the protrusion 130 - passes the inner opening 140 and enters the guide 200.

[282] Specifically, the linear polarization that passes the inner opening 140 moves to the direction changing units 211, 212, 213, 214 formed on the guide 200, hits the protruding ends 221, 222, 223, 224 formed on the direction changing units 211, 212, 213, 214 and changes the advancing direction. The linear polarization having changed

direction is reflected against the reflecting surfaces 231, 232, 233, 234, and enters the guide tubes 241, 242.

[283] After entering from the first and second direction changing units 211, 212 into the first guide tube 241, the linear polarization is mixed at the middle portion of the first guide tube 241 and enters into the relay tube 260. The linear polarization entering from the third and fourth direction changing units 213, 214 into the second guide tube 242, is mixed at the middle portion of the second guide tube 242 and enters into the relay tube 260.

[284] As the linear polarizations from the first and second guide tubes 241, 242 enter into the relay tube 260, the linear polarizations start to be mixed with each other in the middle portion of the relay tube 260, and advance to the mixing tube 280. The linear polarization entering the mixing tube 280 change the advancing direction due to the slant surfaces 291, 292, and move to be discharged.

[285] The process of the horn array antenna 10 for single linear polarization transmitting the electromagnetic waves will be explained below.

[286] The linear polarization waves enter the mixing tube 280 of the guide 200, and split into two streams in the middle portion of the relay tube 250 which are guided into the first and second guide tubes 241, 242, respectively. Accordingly, the waves advance along the first and second guide tubes 241, 242 and move forward to one and the other ends of the first and second guide tubes 241, 242.

[287] The split streams of the linear polarization are reflected against the reflecting surfaces 231, 232, 233, 234 of the direction changing units 211, 212, 213, 214, and provided to the protruding ends 221, 222, 223, 224. The linear polarization provided to the protruding ends 221, 222, 223, 224 change the direction of movement toward the horns 100 as it hits upon the protruding ends 221, 222, 223, 224, and radiated to outside through the inclined portions 120 of the horns 100.

[288] Although the horn array antenna 10 for single linear polarization explained above employs four horns 100, this is only for illustrative purpose. Therefore, it is possible that the horn array antenna 10 for single linear polarization according to embodiments of the present invention can employ more than, or less than four horns 100 as occasion demands.

[289] Meanwhile, in order to improve the receptivity of the single linear polarization at the horn array antenna 10 for single polarization, it is necessary that the entering linear polarization has the direction of electric field that is parallel to the shorter sides of the inner opening 140 (Fig. 101). Referring to Fig. 102, if the linear polarization entering

has the direction of electric field that is not parallel to the shorter sides of the inner opening 140, the horn array antenna 10 for single linear polarization has bad receptivity of linear polarization.

[290] However, the receptivity of linear polarization may still be good even when the linear polarization entering has the direction of electric field that is inclined, rather than parallel to the shorter sides of the inner opening 140. That is, referring to Fig. 103, there is a comb-pattern skew filter provided to the horn array antenna 10 for single linear polarization, and this causes the direction of electric field of the linear polarization to rotate to parallel relation with the shorter sides of the inner opening 140.

[291] The comb pattern of the skew filter may desirably be vertical to the direction of electric field of the linear polarization entering. This is because the direction of the linear polarization is rotated as much as the angle of the teeth of the skew filter. Referring again to Fig. 103, the teeth of the skew filter are inclined at approximately 30°. Accordingly, the direction of the linear polarization which is entering at 30°of inclination from the shorter sides of the inner opening 140, rotates by 30°according to the angle of the teeth of the skew filter, to enter the inner opening 140 in parallel relation with the shorter sides (that is, the direction of electric field of the linear polarization illustrated in Fig. 101).

[292] Meanwhile, the angle of incidence of the linear polarization is different depending on the location (latitude and longitude) of the area where the horn array antenna 10 is used, and this means that the angle of incidence of the linear polarization can be computed based on the latitude and longitude of the location to receive the linear polarization. Accordingly, based on the latitude and longitude of the area to receive the linear polarization, the angle of teeth of the skew filter can be decided.

[293] The skew filter may be embodied using conductive materials such as copper, nickel, or iron, or alternatively, the skew filter may desirably be embodied by plating synthetic resin with an adequate conductive material. The skew filter may preferably have 0.03mm to 1mm of thickness, but this may vary as occasion demands.

[294] Figs. 104 to 107 illustrate a method for applying a skew filter to the horn array antenna 10 for single linear polarization according to embodiments of the present invention.

[295] Referring to Fig. 104, a skew filter 410 provided as a film may be inserted between the first and second layers 310, 320. Secondly, referring to Fig. 105, a skew filter may be formed directly on the upper portion of the second layer 320.

[296] According to the abovementioned first and second methods, the skew filter is formed

on the lower portion of the horns 100. The ends of the teeth of the skew filter are in contact with the edge of the inner opening 140. Accordingly, it is possible to change the direction of all the linear polarization entering the inner openings 140.

[297] Thirdly, and referring to Fig. 106, a film type of skew filter 420 may be attached to the upper portion of the first layer 310. Fourthly, and referring to Fig. 107, a skew filter may be formed directly on the upper portion of the first layer 310.

[298] According to the third and fourth methods explained above, the skew filter is formed on the upper side of the horns 100. The ends of the teeth of the skew filter are in contact with the edge of the outer opening 110. Accordingly, it is possible to change the direction of all the linear polarizations entering the outer openings 140.

[299] The number of teeth of the skew is not limited, and therefore, one or more than one teeth may be formed as occasion demands. Furthermore, the width of the tooth, and the intervals between the teeth are not limited. The ends of the teeth may desirably be rounded. Refer to Figs. 79 to 83 for variations of the skew filter.

[300] It is possible that the ends of the teeth of the skew filter are not in contact with the edges of the inner opening 140 or outer opening 110. The ends of the teeth may still be rounded. Figs. 84 to 86 illustrate skew filters whose ends are not in contact with the edges of the inner opening 140. The skew filters illustrated have one tooth, but one will understand that two or more teeth may be employed. Although not illustrated, one will understand that the skew filters may be embodied so that the teeth are not in contact with the edges of the outer opening 110.

[301] Note that only the film type skew filter can have ends of the teeth that do not contact the inner or outer opening 140, 110, and it is necessary to coat the skew filter as a thin layer of nonconductive material to fix the teeth in position.

[302] The teeth of the skew filter may be formed in various manners other than the examples provided above.

[303] In the horn array antenna 10 for single linear polarization explained above according to the embodiments of the present invention, the inner openings 140 are parallel to the outer openings 110 (that is, the edges of the inner openings 140 are parallel to the edges of the outer openings 110). However, even when the inner and outer openings 140, 110 are not parallel, for example, even when the edges of the inner openings 140 are at 45° with respect to the edges of the outer openings 110 (Fig. 87), it is still possible to employ the skew filter according to the embodiments of the present invention.

[304] Furthermore, although the process of the horn array antenna for single linear po-

larization receiving the polarization has been explained so far, one will understand that the same applies to the case of transmitting the polarization so that it is possible to use the skew filter to transmit the polarization having certain degrees of inclination.

[305] Two overlaying skew filters may be used, and a spacer may be inserted between the horn array antenna 10 and the skew filter or between the skew filters to provide a space there between. Refer to the detailed explanation about the spacer provided above with reference to Figs. 88 and 89.

[306] Although the horn array antenna for single linear polarization having a skew filter has been explained above, one will note that the skew filter can be fabricated separately.

[307] While the invention has been shown and described with reference to certain embodiments to carry out this invention, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined by the appended claims.

[308]

Claims

[1] A horn array antenna for dual linear polarization for receiving a first polarization and a second polarization, comprising:
a plurality of horns to which the first and second polarizations enter together;
a plurality of polarization filtering units provided to the horns, to separate the first and second polarizations from the mixture of the first and second polarizations entering the horns;
a first polarization guide to guide the first polarization which is separated at the polarization filtering units; and
a second polarization guide to guide the second polarization which is separated at the polarization filtering units,
wherein the first polarization guide comprises,
a first guide unit to receive the first polarization through one and the other ends thereof, the first polarization received having been separated at the first and second polarization filtering units,
a second guide unit to receive the first polarization through one and the other ends thereof, the first polarization received having been separated at the third and fourth polarization filtering units;
a first relay unit to connect a portion of the first guide unit with a portion of the second guide unit, and mix the first polarization provided from the first and second guide units, and
a first mixing unit connected to a portion of the first relay unit, to receive the first polarization mixed at the first relay unit.

[2] A horn array antenna for dual linear polarization for receiving a first polarization and a second polarization, comprising:
a plurality of horns to which the first and second polarizations enter together;
a plurality of polarization filtering units provided to the horns, to separate the first and second polarizations from the mixture of the first and second polarizations entering the horns;
a first polarization guide to guide the first polarization which is separated at the polarization filtering units; and
a second polarization guide to guide the second polarization which is separated at the polarization filtering units,
wherein the second polarization guide comprises,

a first direction changing unit to change an advancing direction of the second polarization provided from the first polarization filtering unit,
a second direction changing unit to change an advancing direction of the second polarization provided from the second polarization filtering unit,
a third direction changing unit to change an advancing direction of the second polarization provided from the third polarization filtering unit,
a fourth direction changing unit to change an advancing direction of the second polarization provided from the fourth polarization filtering unit,
a first guide unit to connect the first and third direction changing units, and mix the second polarization provided from the first and third direction changing units,
a second guide unit to connect the second and fourth direction changing units, and mix the second polarization provided from the second and fourth direction changing units,
a first relay unit to connect a portion of the first guide unit with a portion of the second guide unit, and mix the second polarization provided from the first and second guide units, and
a first mixing unit connected to a portion of the first relay unit, to guide so that the second polarization provided from the first relay unit is emerged.

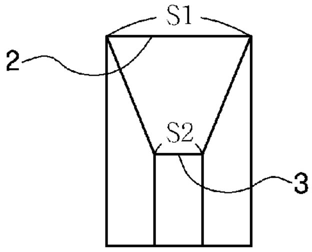
[3] A horn array antenna for dual linear polarization for receiving a first polarization and a second polarization, comprising:
a plurality of horns to which the first and second polarizations enter together;
a plurality of polarization filtering units to separate the first and second polarizations from the mixture of the first and second polarizations entering the horns;
a first polarization guide to guide the first polarization which is separated at the polarization filtering units; and
a second polarization guide to guide the second polarization which is separated at the polarization filtering units,
wherein an upper portion of the polarization filtering unit is in a square box shape, and a lower portion of the polarization filtering unit is in a narrower square box shape.

[4] A horn array antenna for dual linear polarization for receiving a first polarization and a second polarization, comprising:
a plurality of horns to which the first and second polarizations enter together;

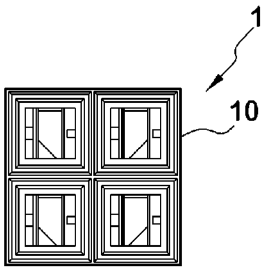
a plurality of polarization filtering units to separate the first and second polarizations from the mixture of the first and second polarizations entering the horns;
a first polarization guide to guide the first polarization which is separated at the polarization filtering units;
a second polarization guide to guide the second polarization which is separated at the polarization filtering units; and
a skew filter to change an angle of at least one of the first and second polarizations.

[5] A horn array antenna comprising:
a plurality of horns to which electromagnetic waves enter;
a guide to guide the electromagnetic waves entering into the horns; and
a skew filter to change an angle of the electromagnetic waves.

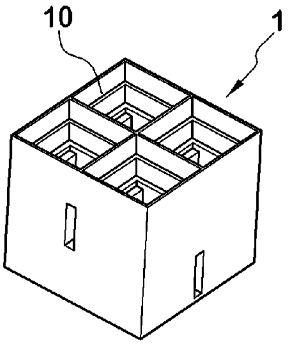
[Fig. 1]



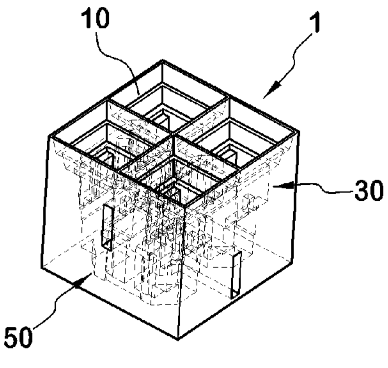
[Fig. 2]



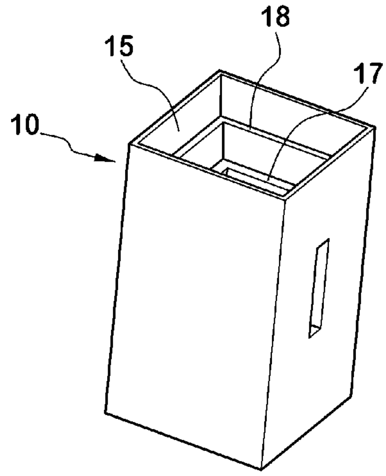
[Fig. 3]



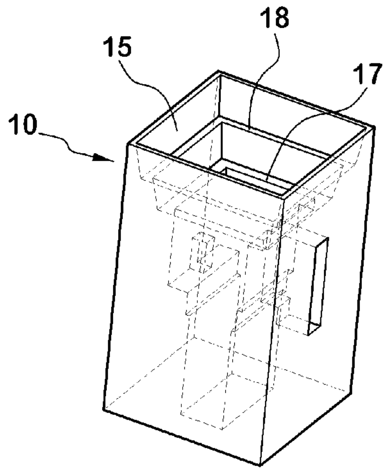
[Fig. 4]



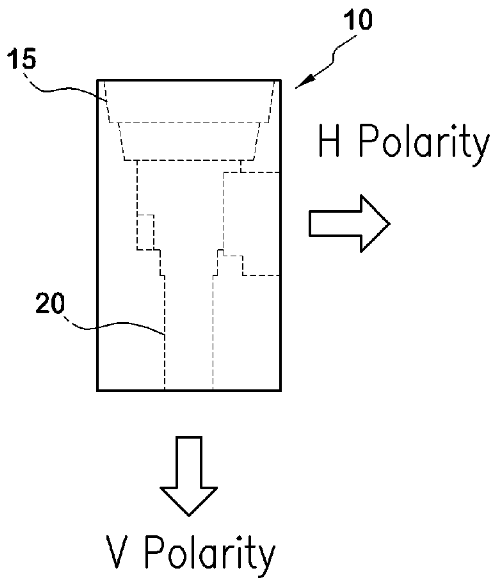
[Fig. 5]



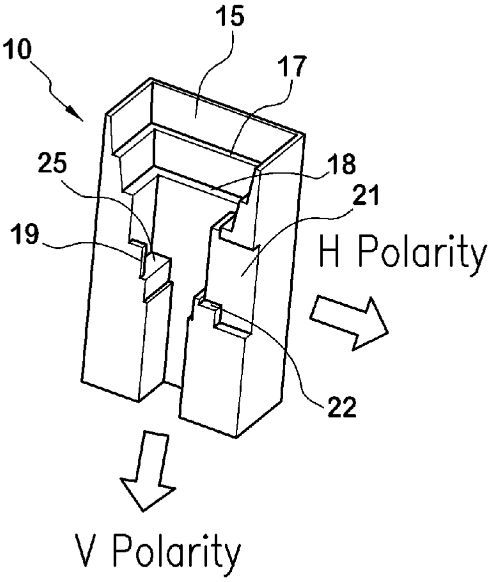
[Fig. 6]



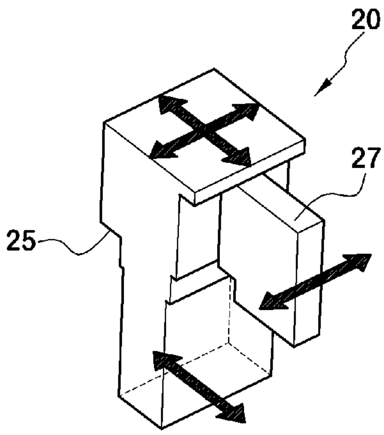
[Fig. 7]



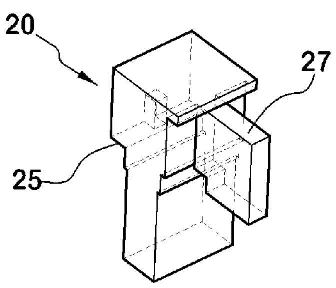
[Fig. 8]



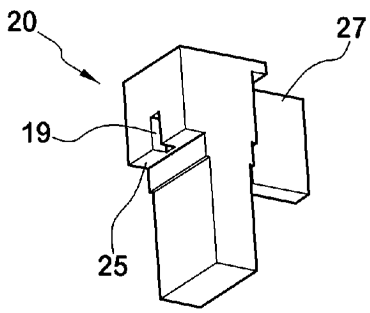
[Fig. 9]



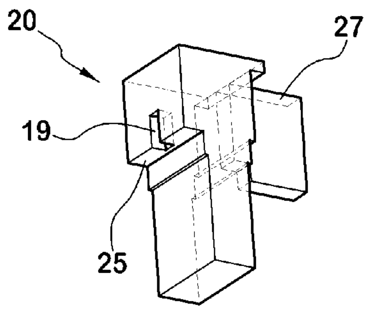
[Fig. 10]



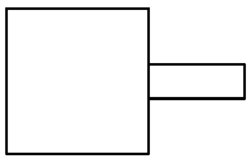
[Fig. 11]



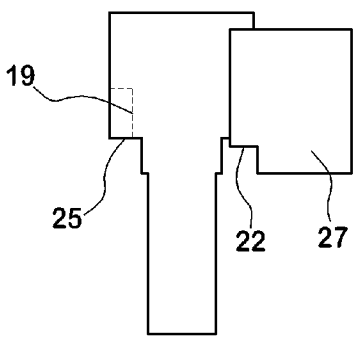
[Fig. 12]



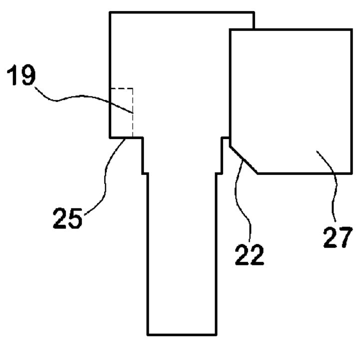
[Fig. 13]



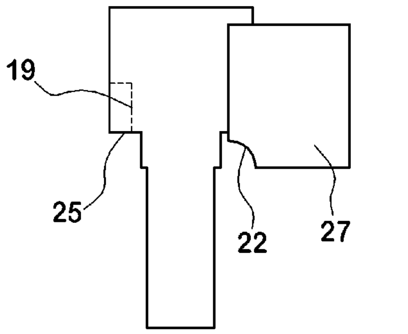
[Fig. 14]



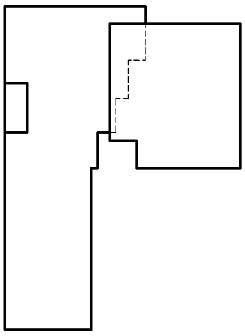
[Fig. 15]



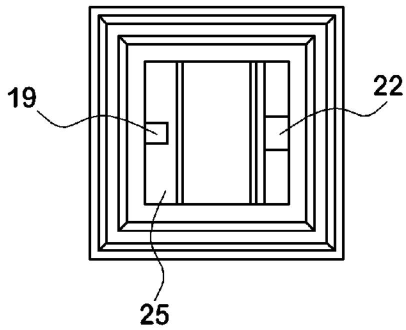
[Fig. 16]



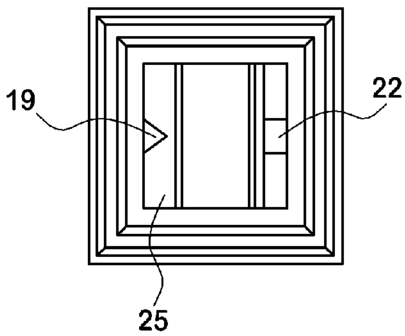
[Fig. 17]



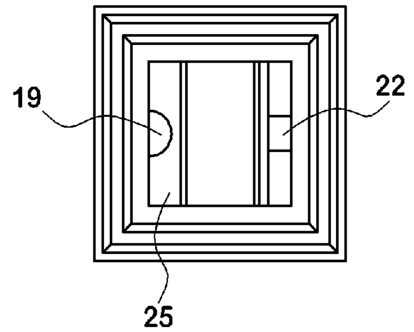
[Fig. 18]



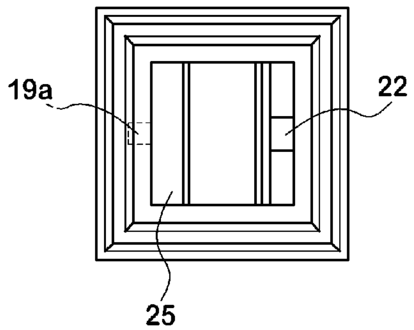
[Fig. 19]



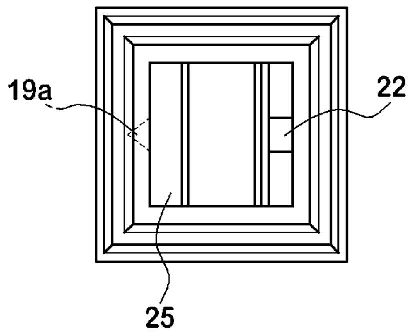
[Fig. 20]



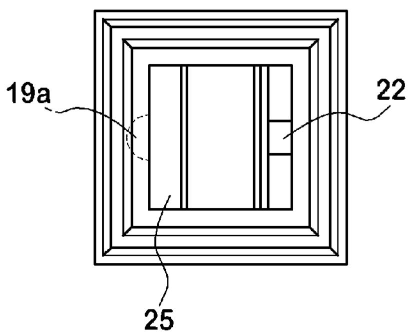
[Fig. 21]



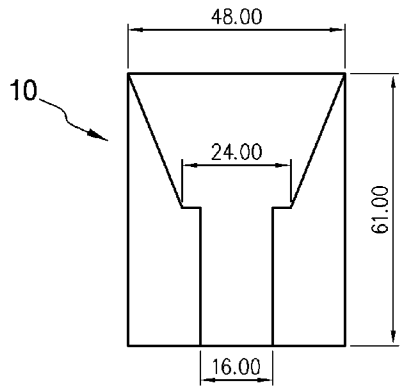
[Fig. 22]



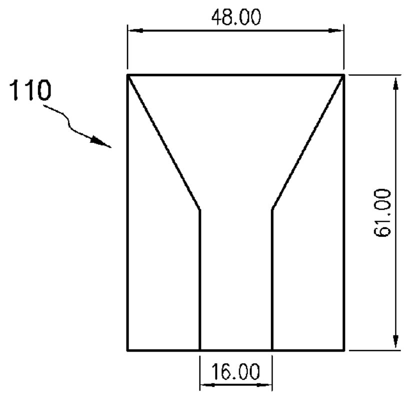
[Fig. 23]



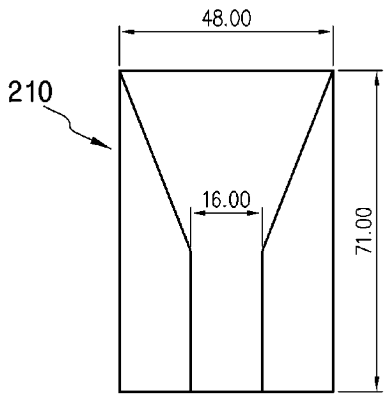
[Fig. 24]



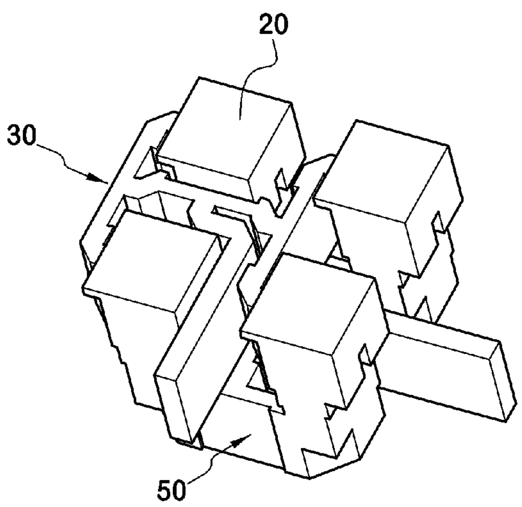
[Fig. 25]



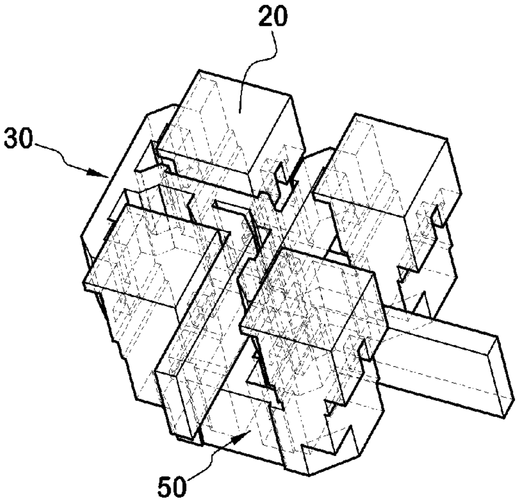
[Fig. 26]



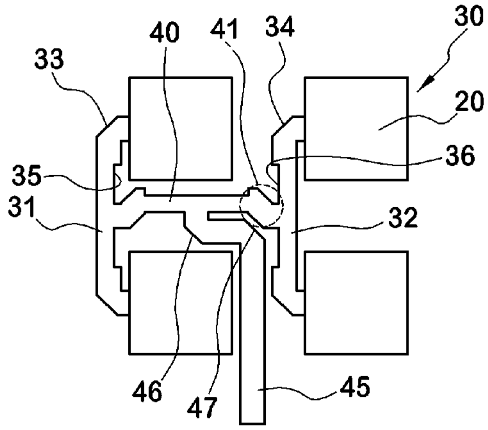
[Fig. 27]



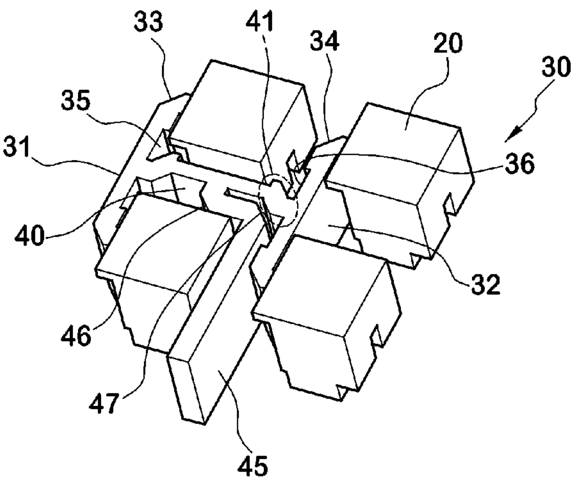
[Fig. 28]



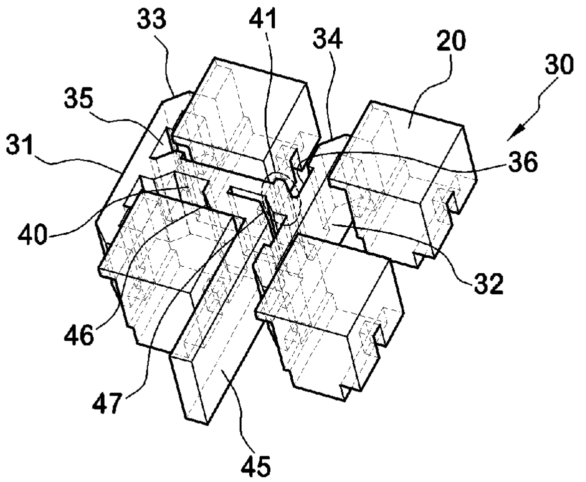
[Fig. 29]



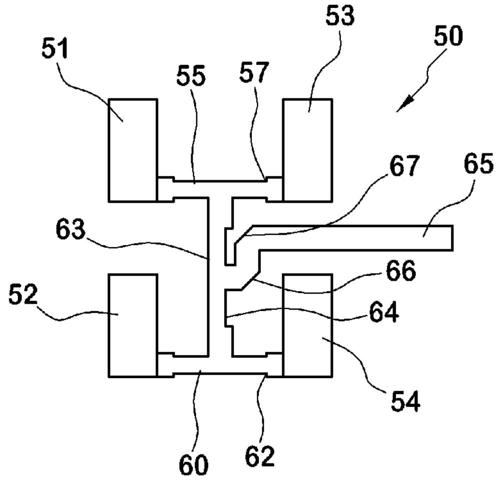
[Fig. 30]



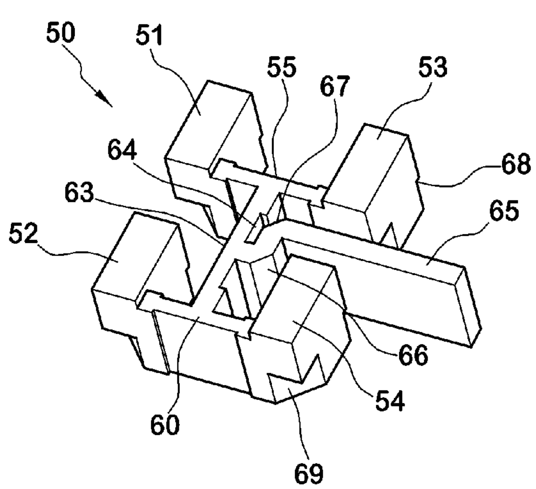
[Fig. 31]



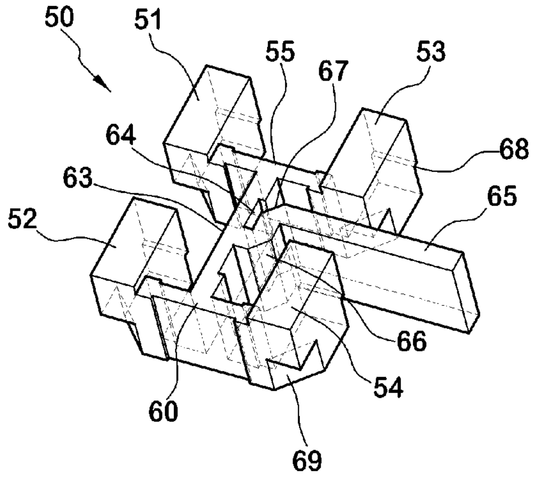
[Fig. 32]



[Fig. 33]



[Fig. 34]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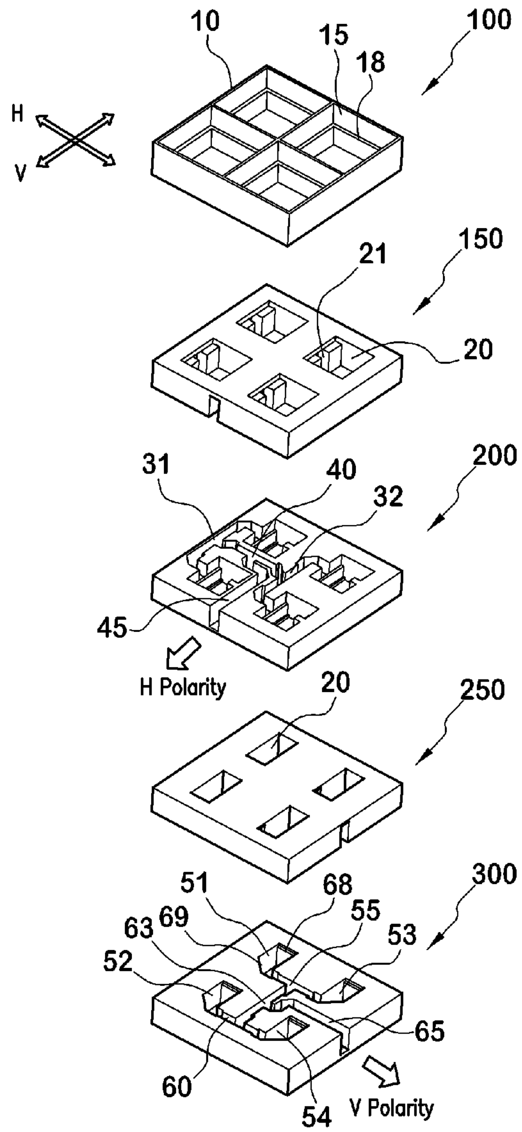
[Fig. 35]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15
18
100
H
V
21
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31
40
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200
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H Polarity
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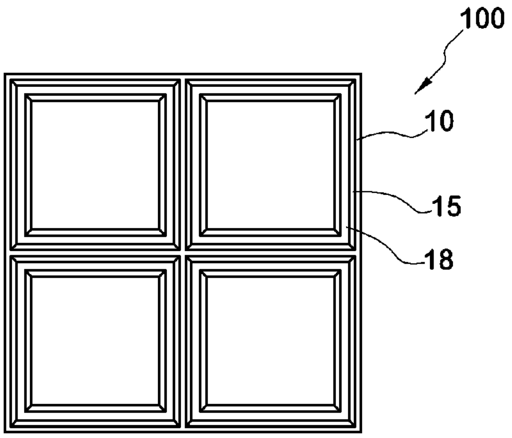
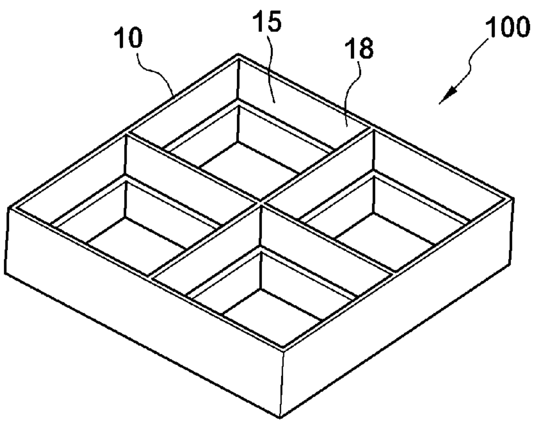
V Polarity

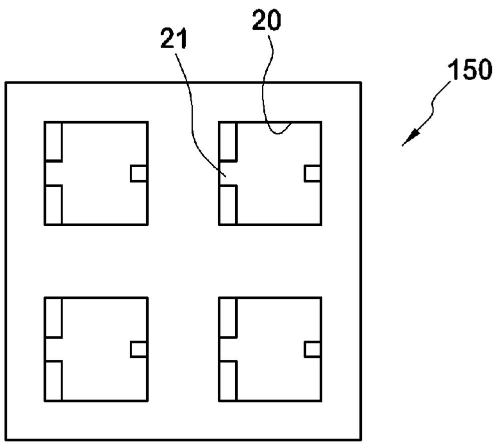
[Fig. 36]



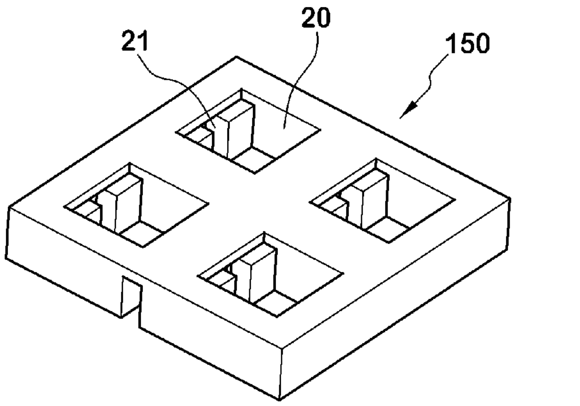
[Fig. 37]



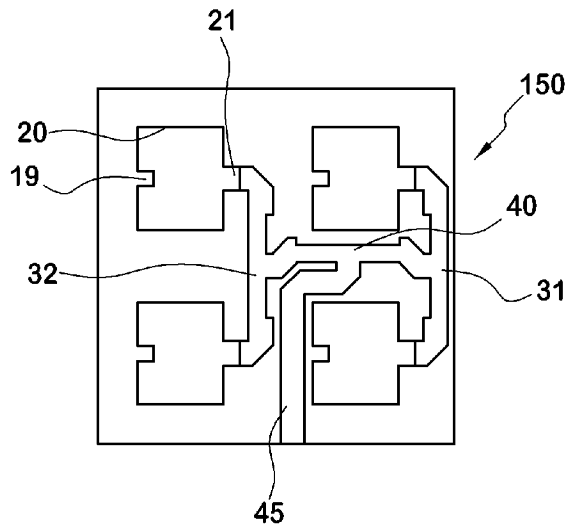
[Fig. 38]



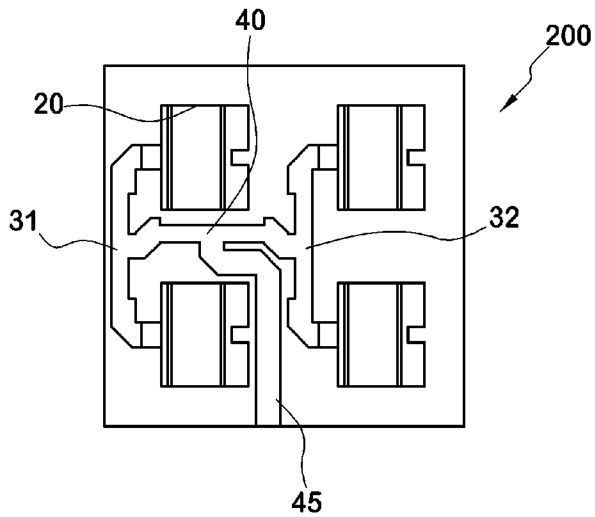
[Fig. 39]



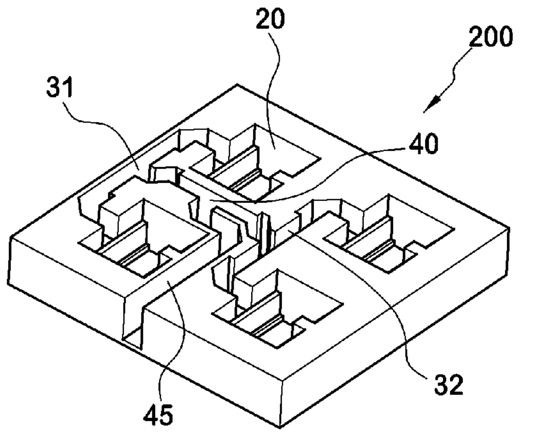
[Fig. 40]



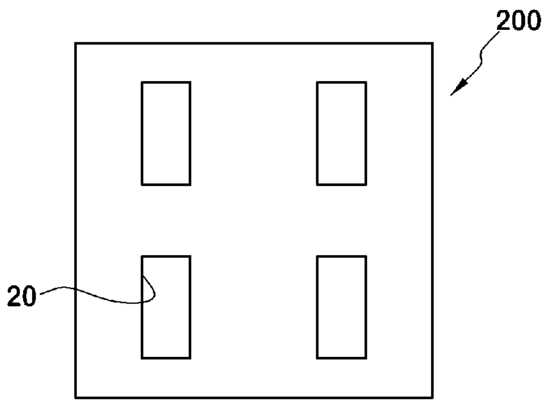
[Fig. 41]



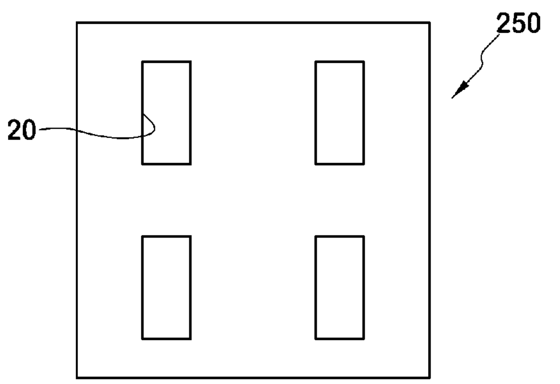
[Fig. 42]



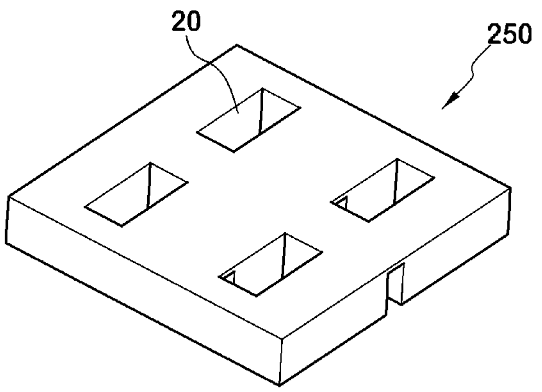
[Fig. 43]



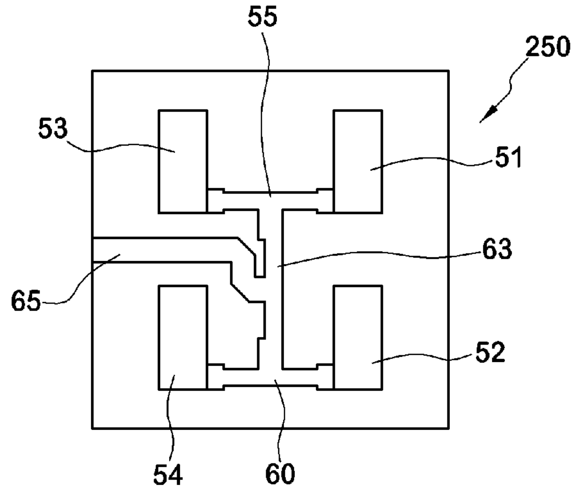
[Fig. 44]



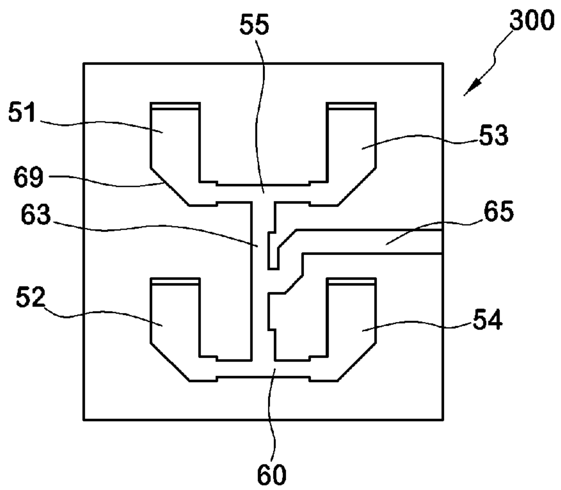
[Fig. 45]



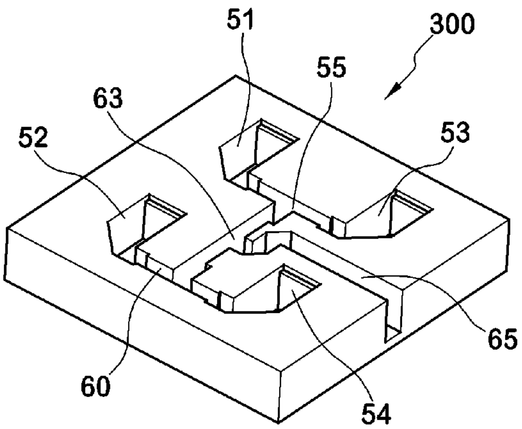
[Fig. 46]



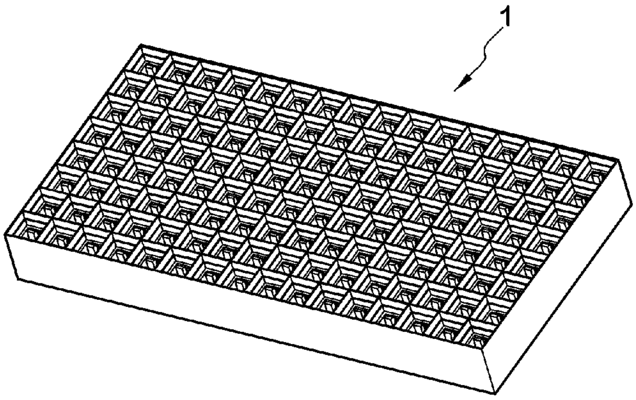
[Fig. 47]



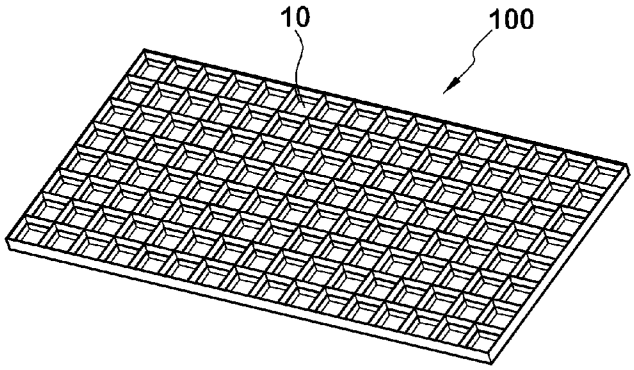
[Fig. 48]



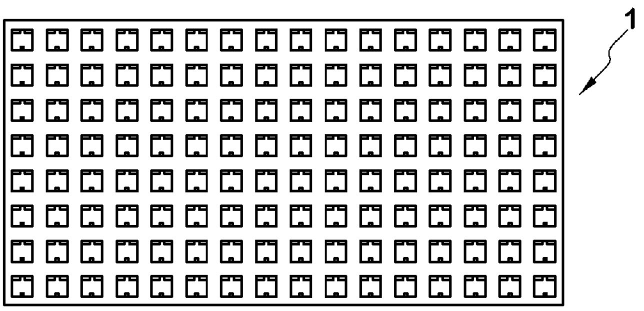
[Fig. 49]



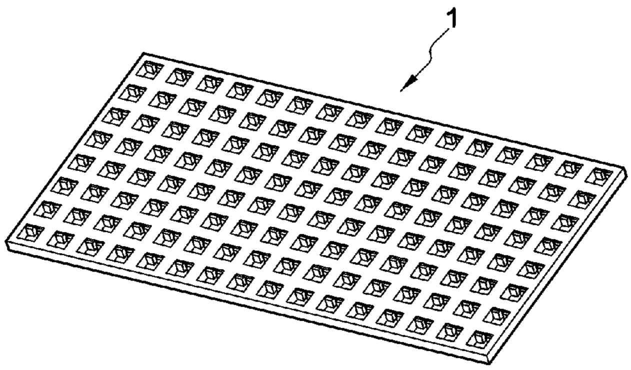
[Fig. 50]



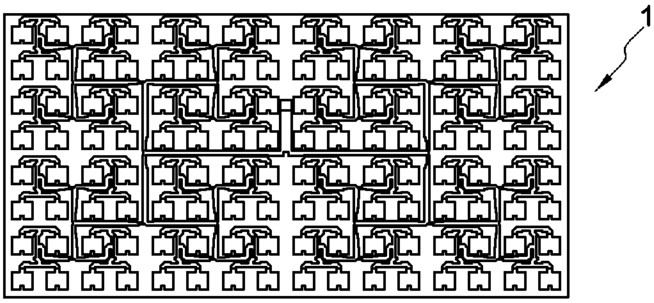
[Fig. 51]



[Fig. 52]



[Fig. 53]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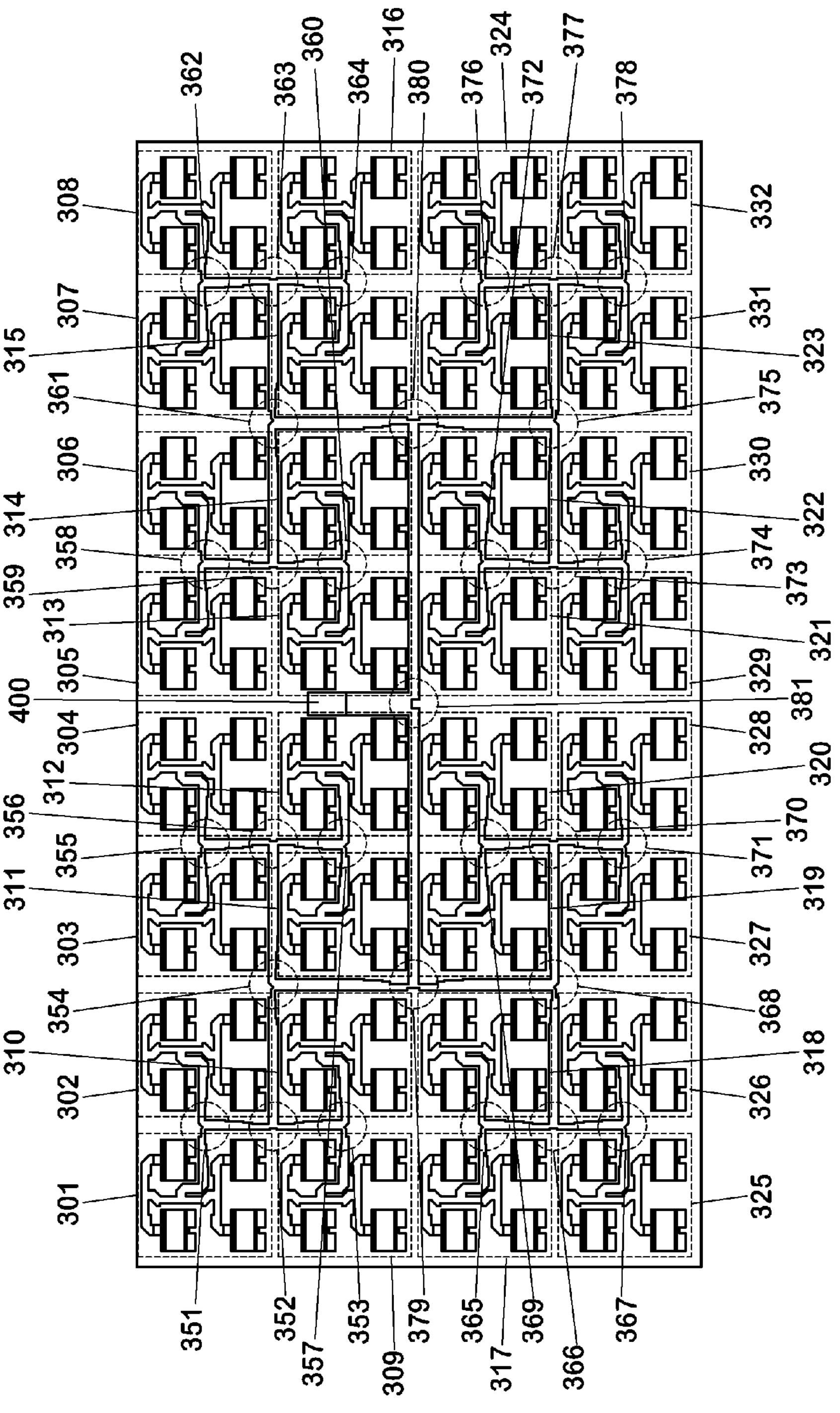
[Fig. 54]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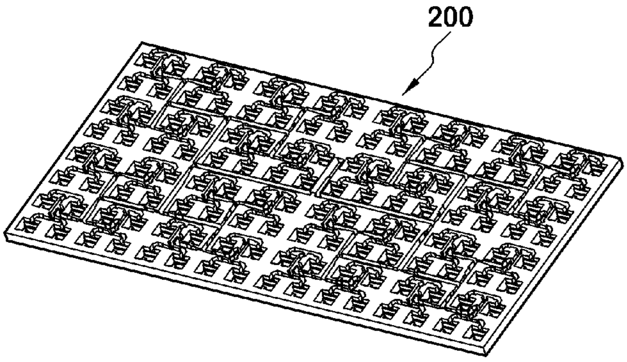
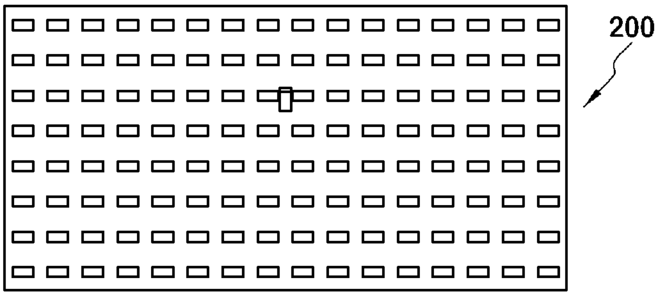
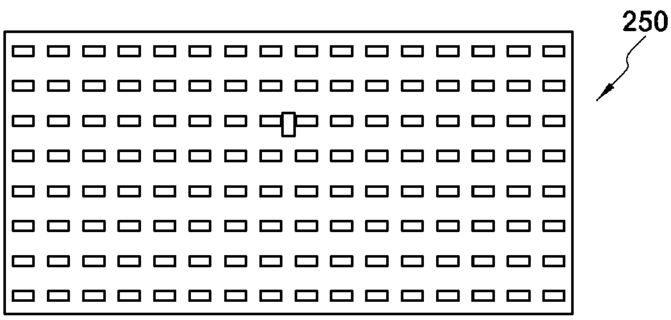
[Fig. 55]



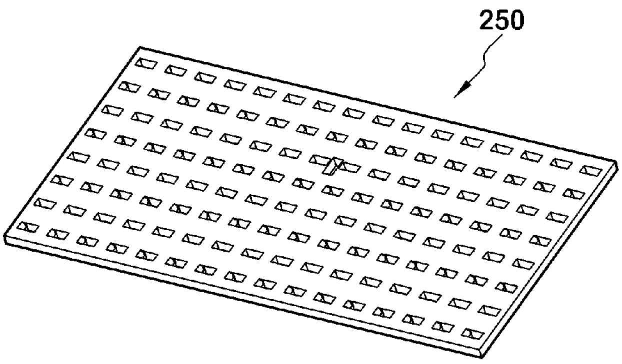
[Fig. 56]



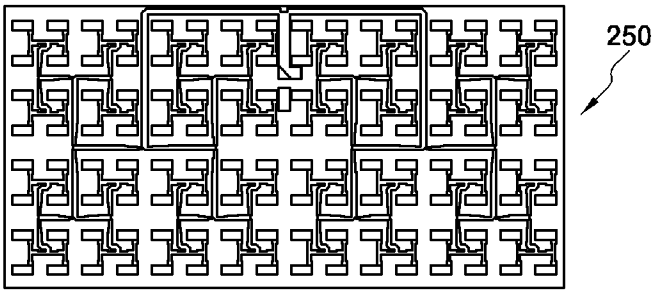
[Fig. 57]



[Fig. 58]



[Fig. 59]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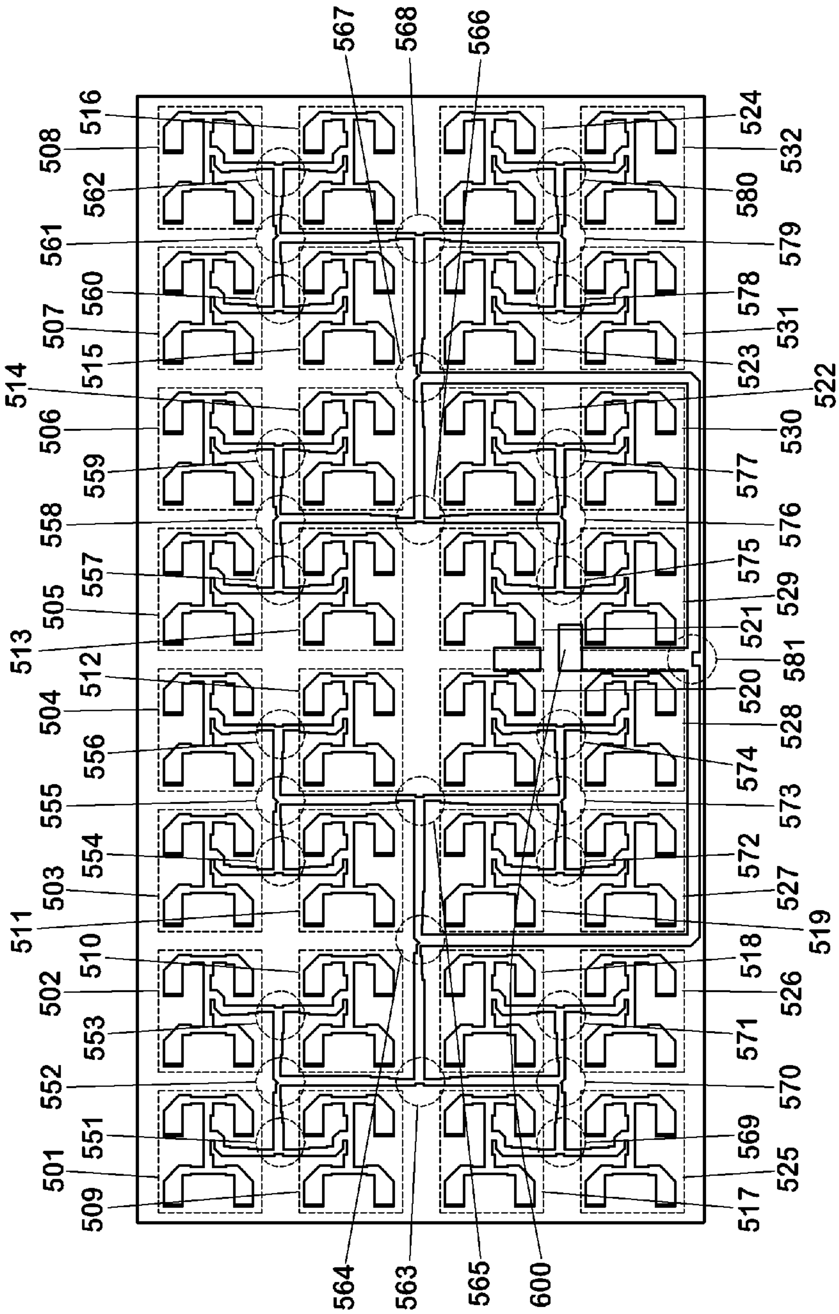
[Fig. 60]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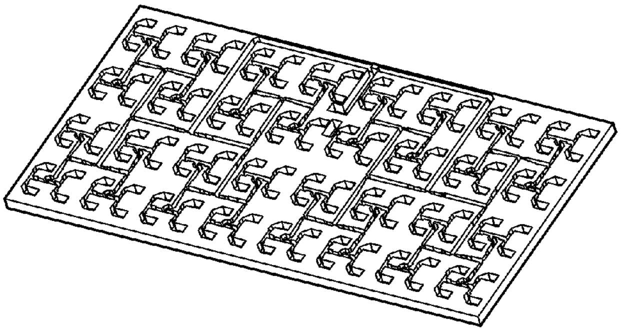
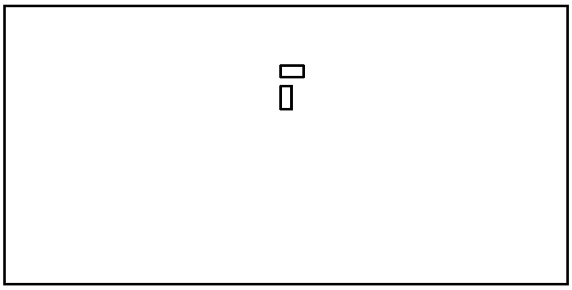
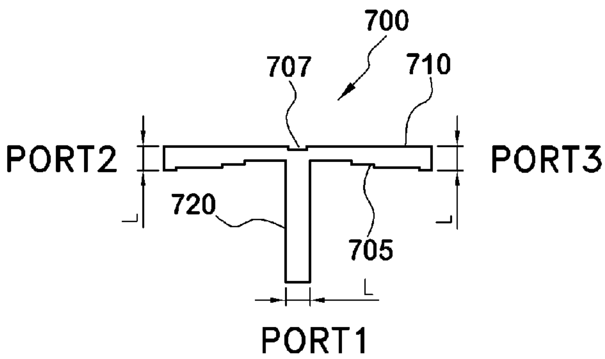
[Fig. 61]



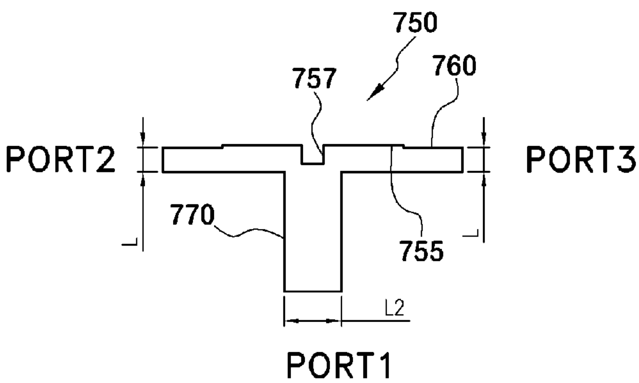
[Fig. 62]



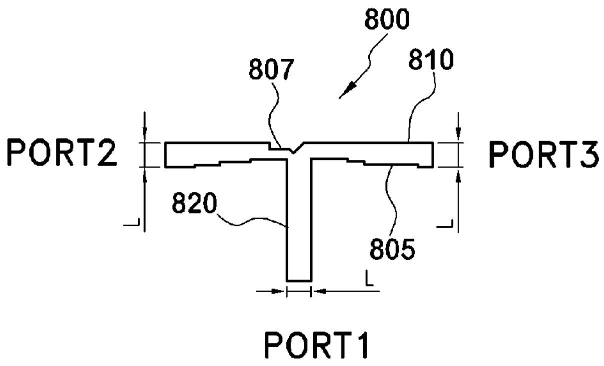
[Fig. 63]



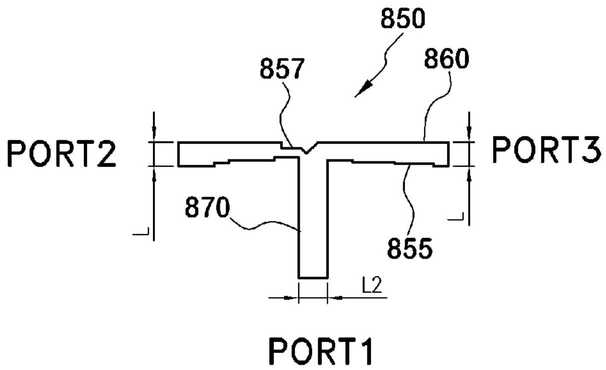
[Fig. 64]



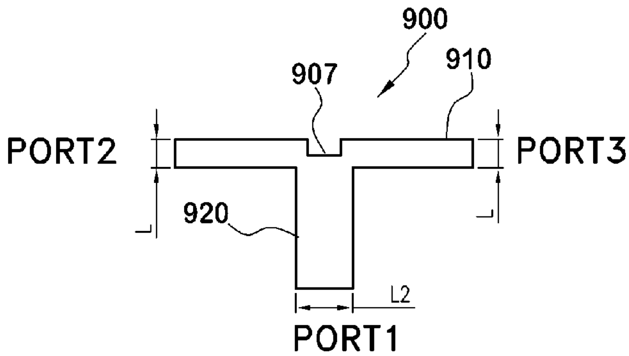
[Fig. 65]



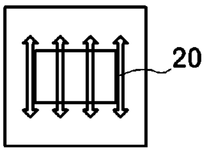
[Fig. 66]



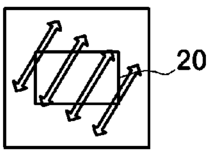
[Fig. 67]



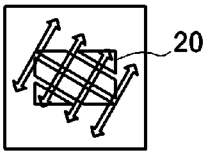
[Fig. 68]



[Fig. 69]



[Fig. 70]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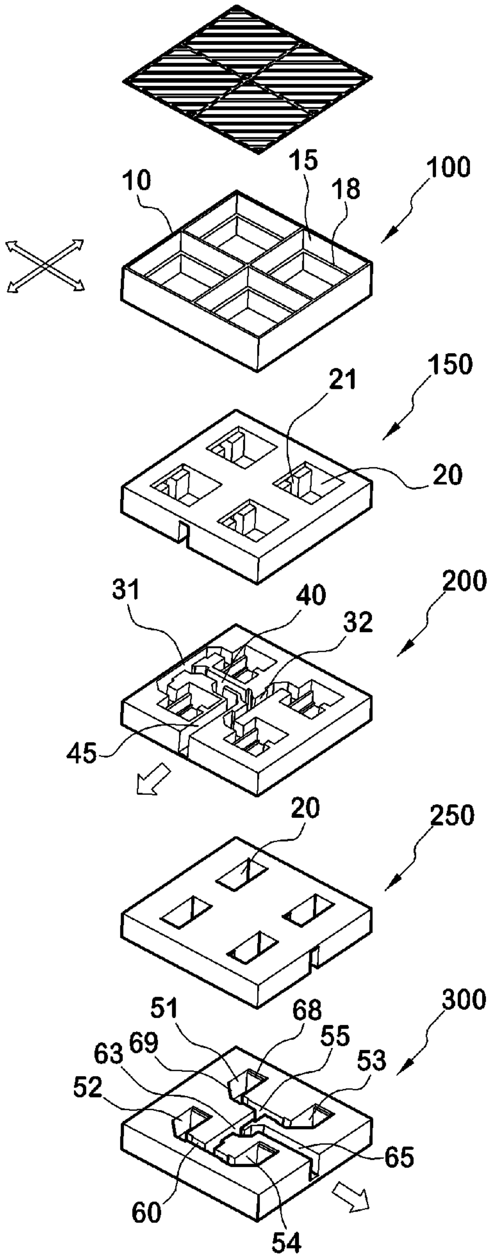
[Fig. 71]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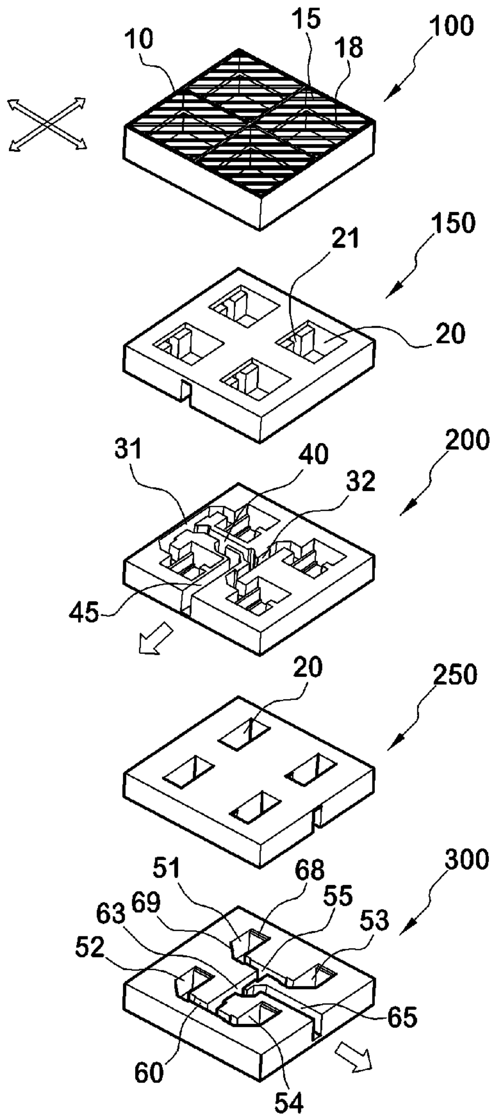
[Fig. 72]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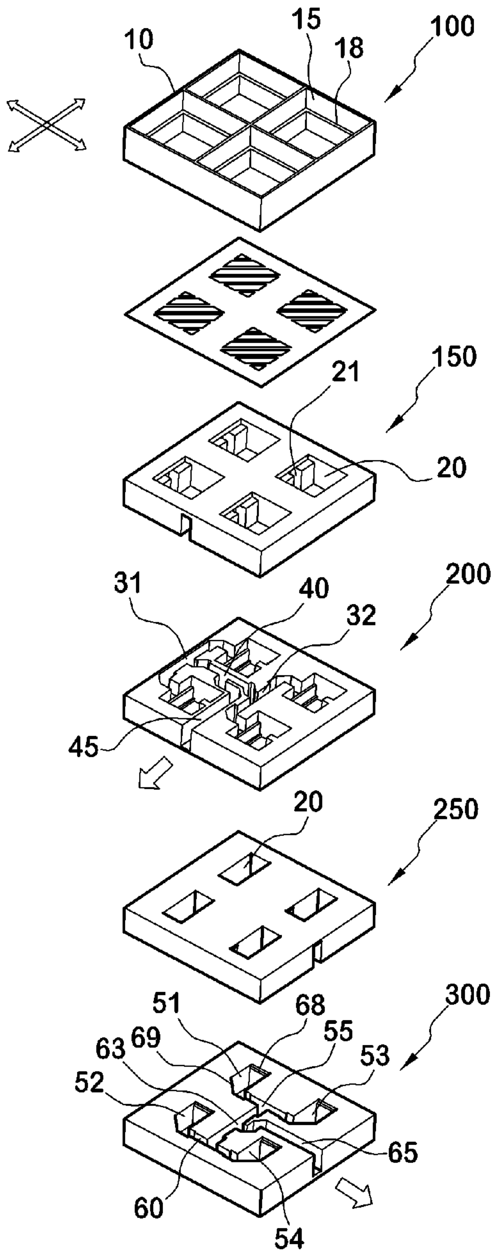
[Fig. 73]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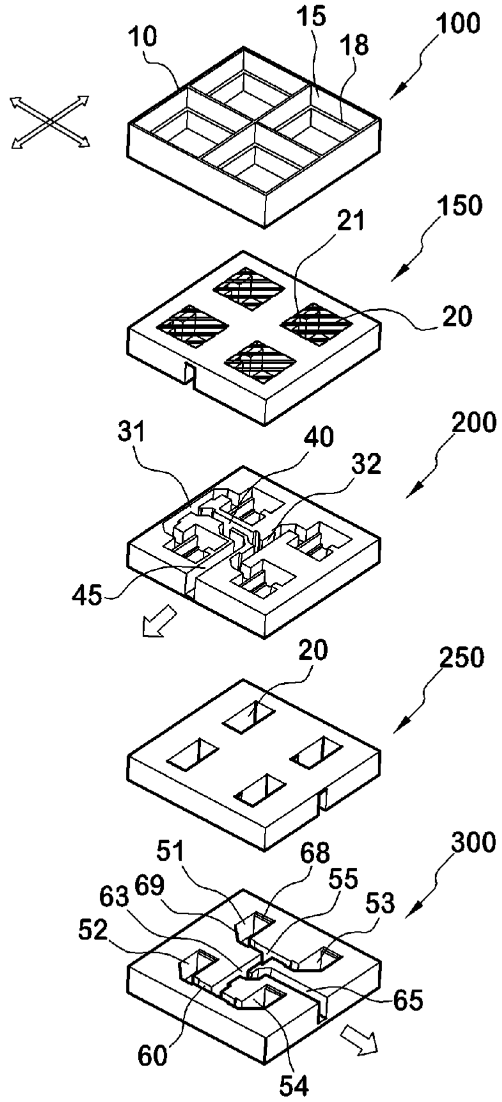
[Fig. 74]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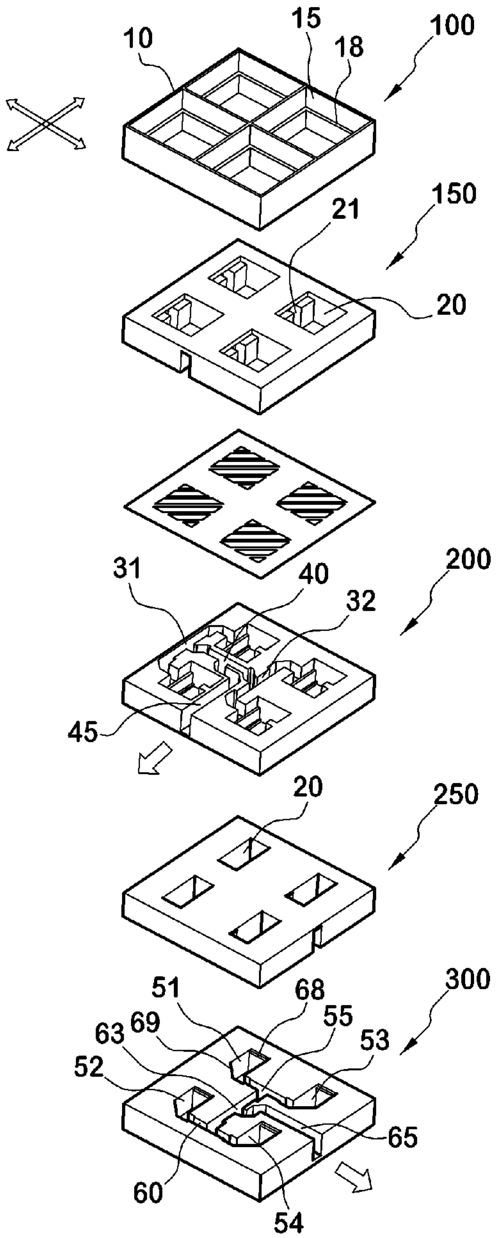
[Fig. 75]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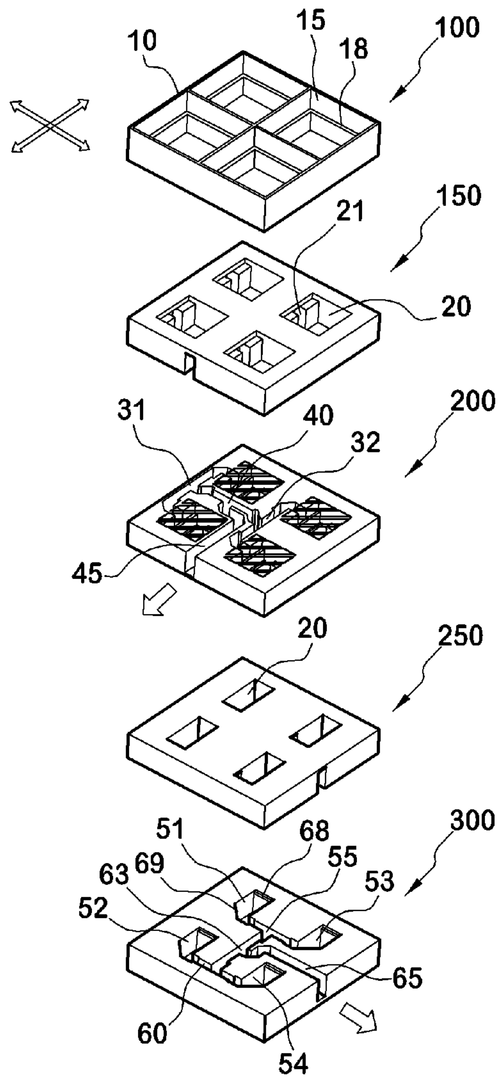
[Fig. 76]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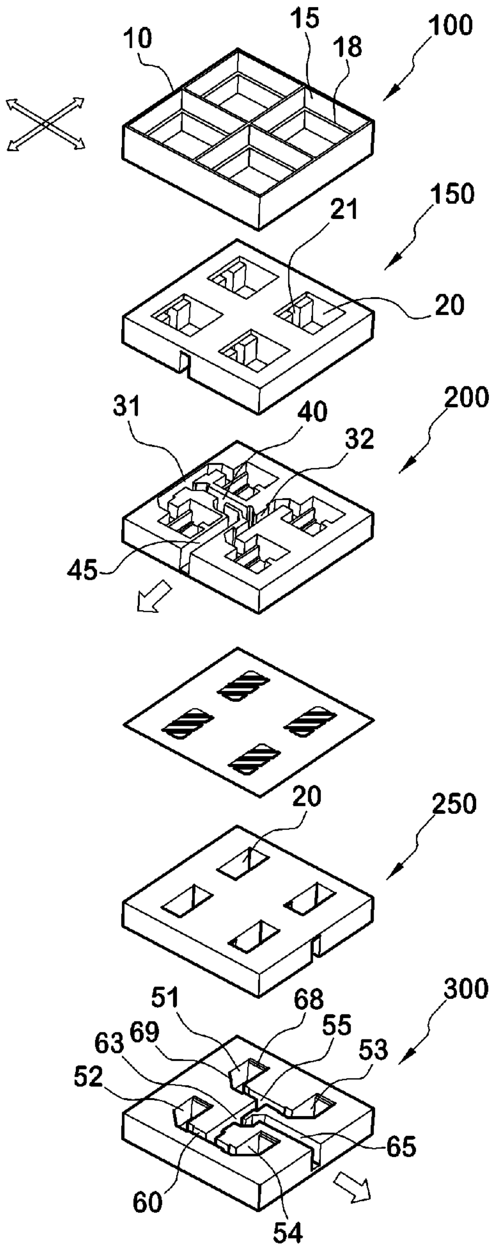
[Fig. 77]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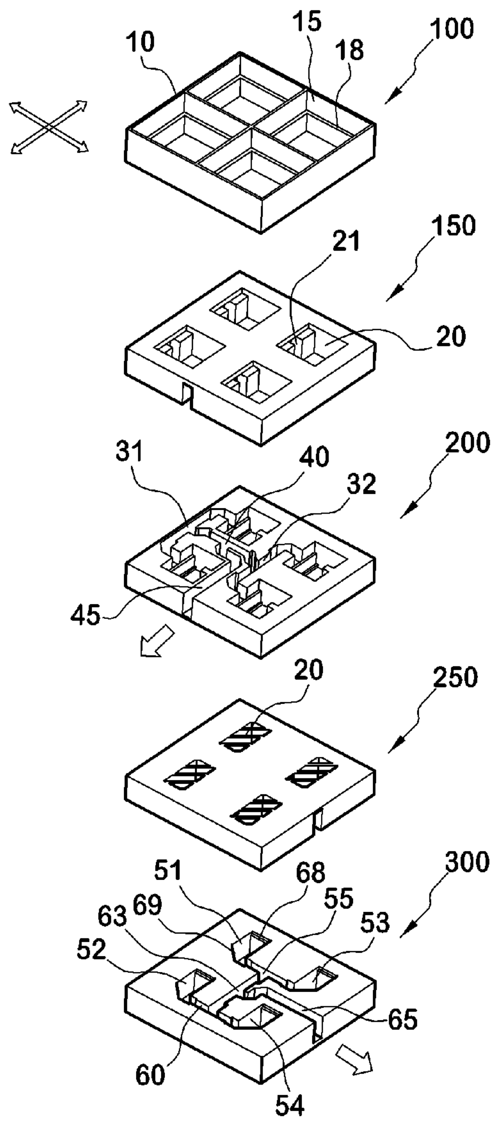
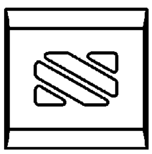
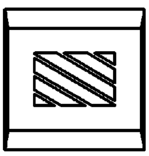
[Fig. 78]



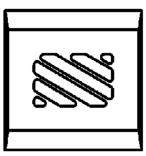
[Fig. 79]



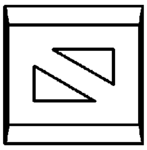
[Fig. 80]



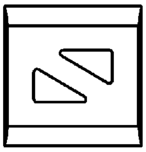
[Fig. 81]



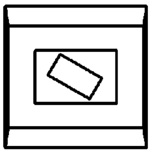
[Fig. 82]



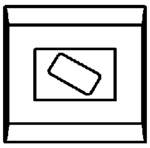
[Fig. 83]



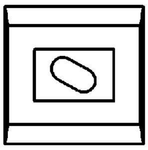
[Fig. 84]



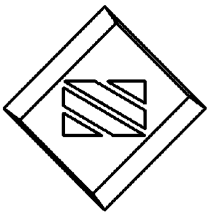
[Fig. 85]



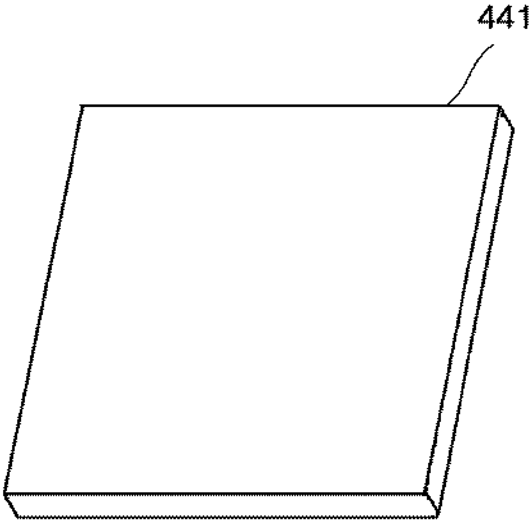
[Fig. 86]



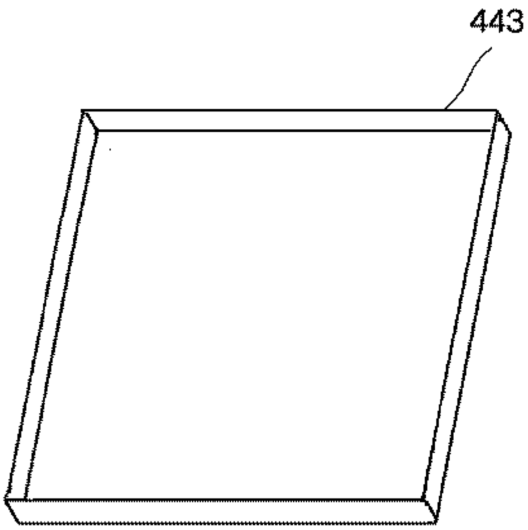
[Fig. 87]



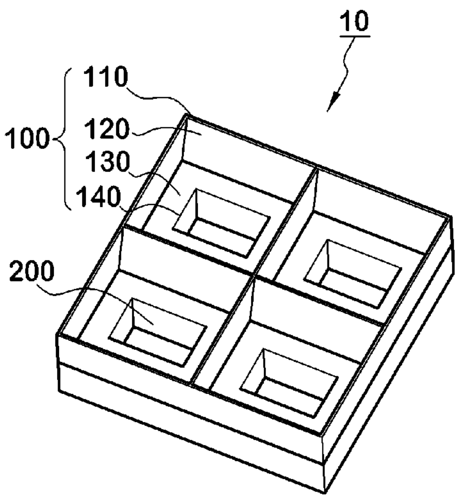
[Fig. 88]



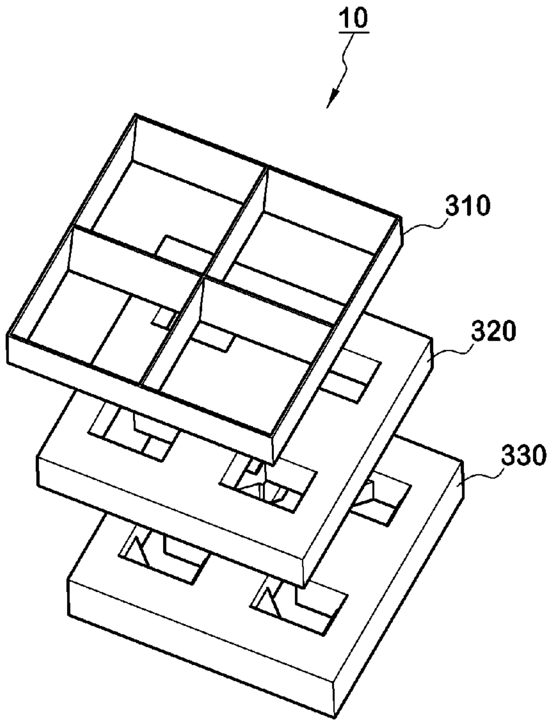
[Fig. 89]



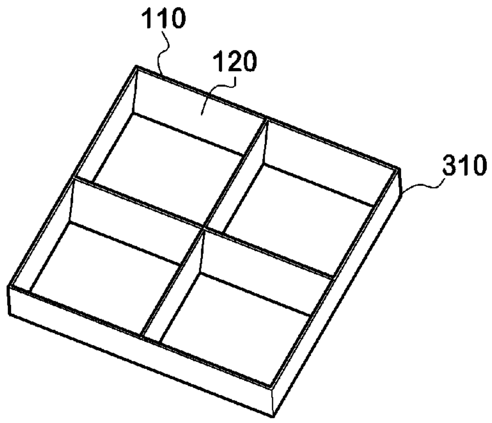
[Fig. 90]



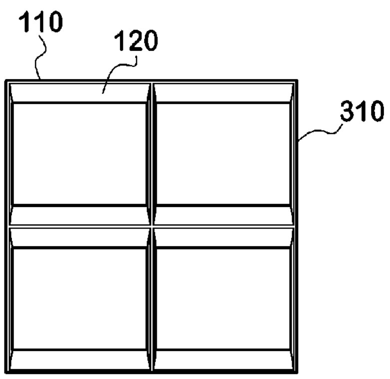
[Fig. 91]



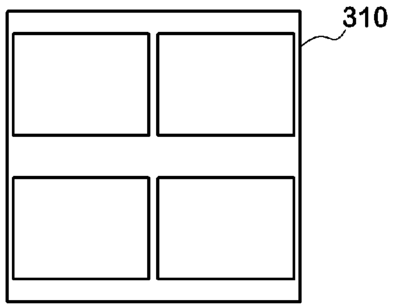
[Fig. 92]



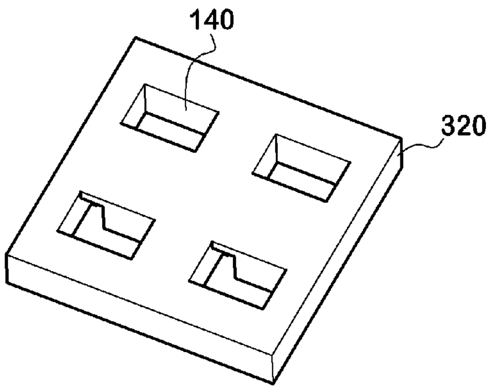
[Fig. 93]



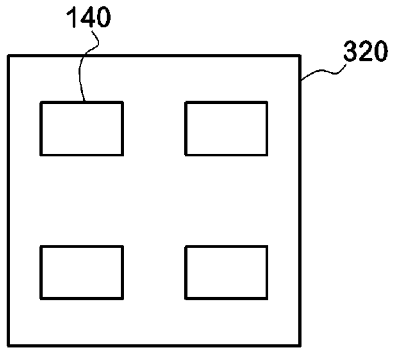
[Fig. 94]



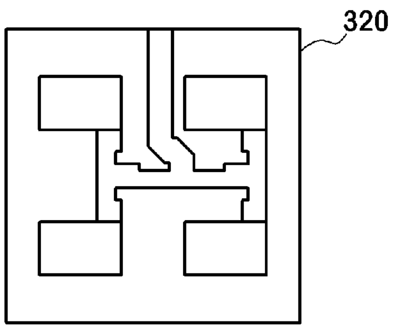
[Fig. 95]



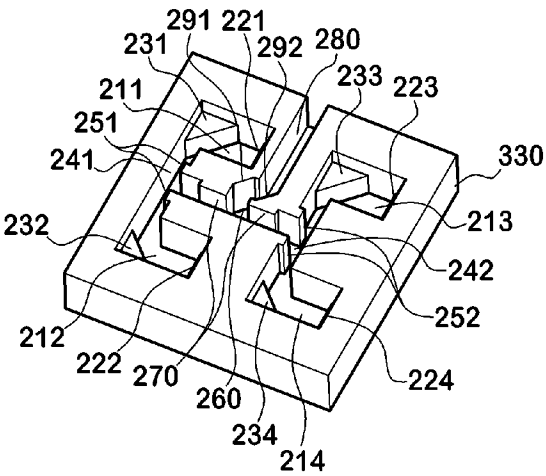
[Fig. 96]



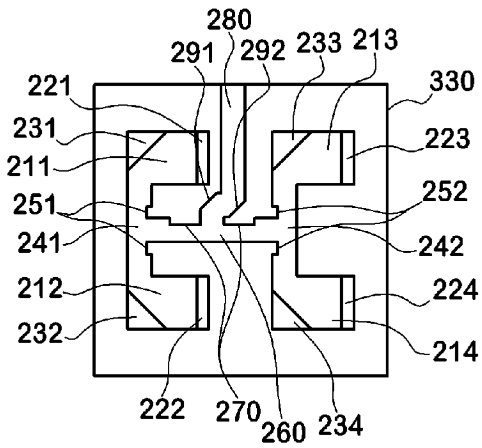
[Fig. 97]



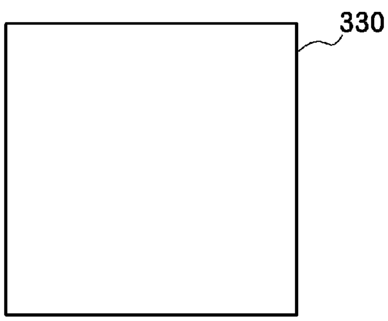
[Fig. 98]



[Fig. 99]



[Fig. 100]



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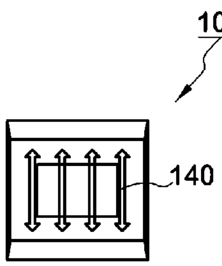
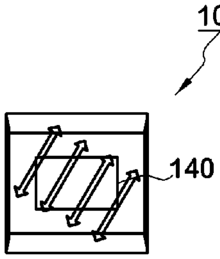
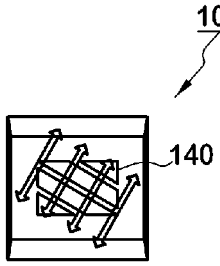


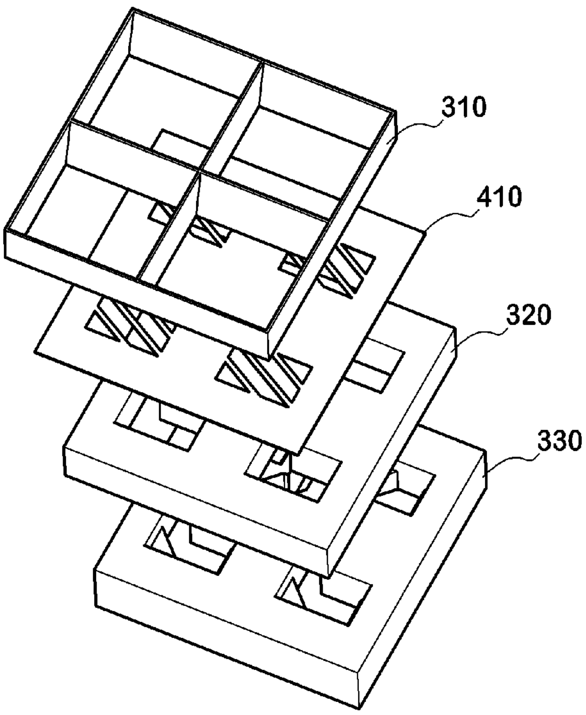
[Fig. 102]



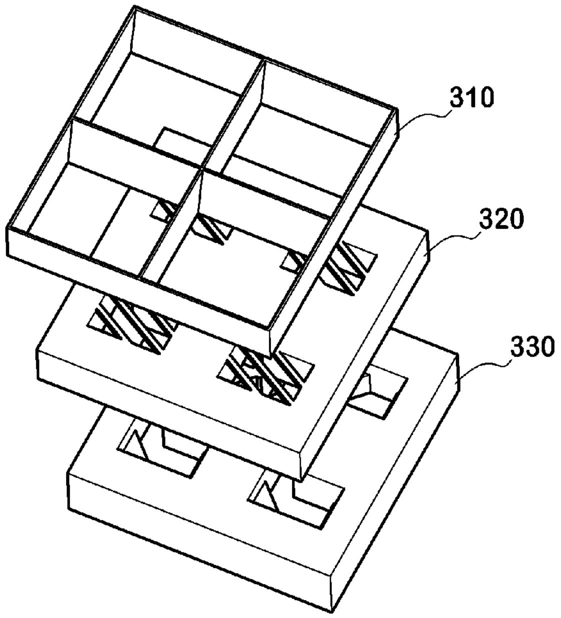
[Fig. 103]



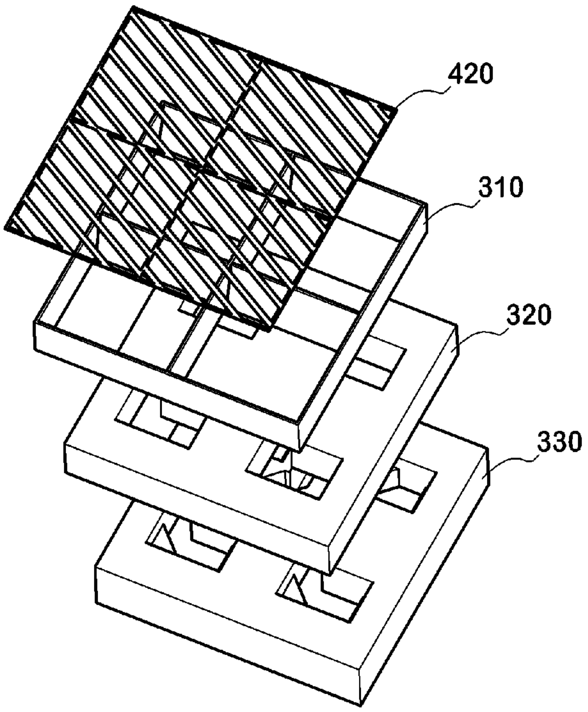
[Fig. 104]



[Fig. 105]



[Fig. 106]



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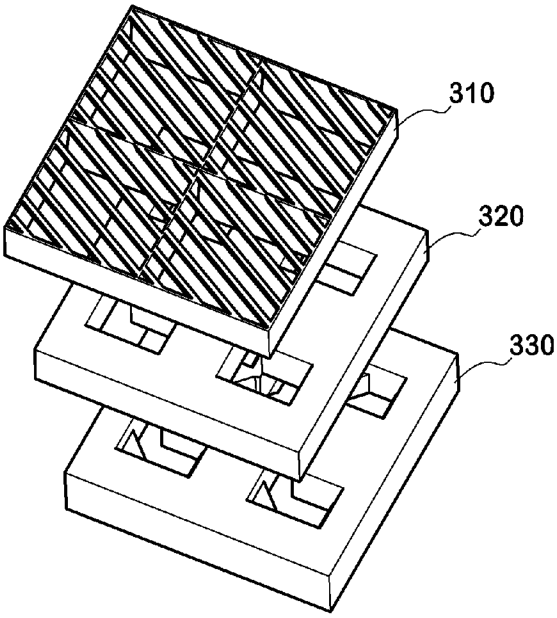

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2008/005145

A. CLASSIFICATION OF SUBJECT MATTER

H01Q 13/02(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 8 H01Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean Utility models and applications for utility models since 1975
Japanese Utility models and applications for utility models since 1975

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKIPASS(KIPO Internal)
"Keywords: antenna, horn, waveguide, polarization, polarizer, skew"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	WO 9523440 A1 (FORTEL TECHNOLOGY LIMITED) 31 AUGUST 1995 See the abstract; figures 1, 2, 4, 5; pages 3~5; and claims 1~5	1~3 4, 5
Y A	WO 03017424 A1 (ARGUS TECHNOLOGIES (AUSTRALIA) PTY LTD et al.) 27 FEBRUARY 2003 See the abstract; figures 1A, 1B; page 4 line 19 ~ line 25; and claim 1	4, 5 1~3
A	JP 2001189618 A (SPACE SYSTEMS / LORAL, INC.) 10 JULY 2001 See the abstract; figures 1~6, 9, 10; paragraphs 7, 13~16, 24, 25; and claims 1~3, 5, 8	1~5
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☐ Further documents are listed in the continuation of Box C.　　☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
09 JANUARY 2009 (09.01.2009)	**09 JANUARY 2009 (09.01.2009)**

Name and mailing address of the ISA/KR
Korean Intellectual Property Office
Government Complex-Daejeon, 139 Seonsa-ro, Seo-gu, Daejeon 302-701, Republic of Korea
Facsimile No. 82-42-472-7140

Authorized officer
NAM, Yun Kwon
Telephone No. 82-42-481-8357

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/KR2008/005145

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2008/005145

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See Separate Sheet.

1. ☐ As all required addtional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

Continuation of:

(BOX No. Ⅲ)

Claims 1~4 are directed to a horn array antenna for dual linear polarization for receiving a first polarization and a second polarization, comprising: a plurality of horns; a plurality of polarization filtering units; a first polarization guide; and a second polarization guide.

It is considered that the horn array antenna for dual linear polarization for receiving a first polarization and a second polarization comprises a first special technical feature.

Claim 5 is directed to a horn array antenna comprising: a plurality of horns; a guide; and a skew filter.

It is considered that the horn array antenna comprises a second special technical feature.

Since the above mentioned groups of claims do not share any of the technical features identified, a technically special relationship between the inventions does not exist. Accordingly the claims do not relate to one invention or to a single inventive concept, a priori.