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TRANSMISSION SYSTEM FOR RADIOELECTRIC WAVES

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FIG. 1.

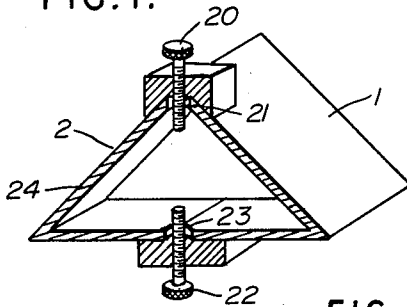


FIG. 2.

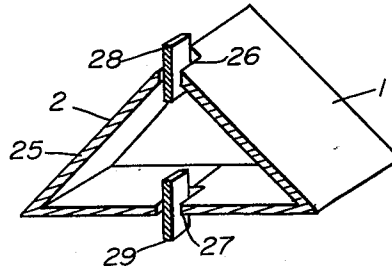
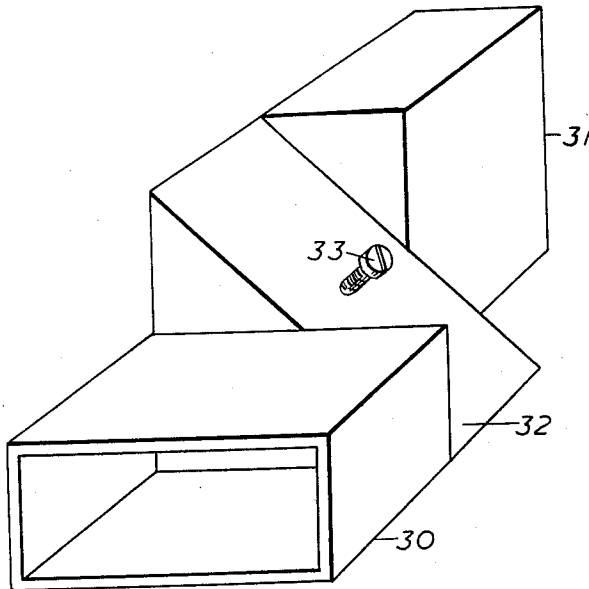


FIG. 3.



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1

2,921,274

TRANSMISSION SYSTEM FOR RADIOELECTRIC WAVES

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6 Claims. (Cl. 333—27)

The present invention relates to transmission systems for radioelectric waves and more particularly to improvements in wave guides used for propagating energy at very high frequency.

There is used at present, in the art, wave guides of rectangular or circular cross-section. The rectangular cross section wave guides have the advantage of being able to propagate under certain conditions high frequency energy with a unique and stable mode of vibration; however such wave guides are subject to mechanical deformation, particularly they may be deformed into a parallelepiped with an oblique cross section thus leading to the use of very thick walls thus rendering more complex and more expensive the manufacture of such dielectric guides. Circular cross-section wave guides are more easy to manufacture but it is difficult to maintain in such a guide a unique and stable mode of vibration. There is also known theoretical works on polygonal cross-section wave guides and in particular triangular cross-section waves section and in this respect references may be made to the books entitled "Electromagnetic Waves" by S. A. Schelkunoff, published by Van Nostrand in New York 1943, page 393 and to "Principles of Microwave Circuits" by C. G. Montgomery, published by McGraw Hill 1948, page 43.

One object of the invention is to provide a triangular cross-section wave guide of simple and inexpensive manufacture.

According to one feature of the invention, it has been found that with a wave guide constituted by a hollow prism, of which right angled cross-section is a rectangular isosceles triangle the electric continuity may be interrupted along two lines corresponding one to the top of the right angle of the cross-section and the other to the middle of the greater side of the triangle without appreciable distortion of the transmission.

According to another feature of the invention, in a triangular wave guide, of which a right angled cross-section is a right angled isosceles triangle, impedance matching devices of the screw type or blade attenuators may be introduced along the two lines of cutting, the action of the device inserted in the slit made along the edge corresponding to the middle of the greater side of the triangle having a fast action, the other device playing the part of a vernier.

According to another feature of the invention, a circuit element to cause a rotation to the polarisation plane in a wave guide comprises in combination, two rectangular cross-section wave guides of which the axes are parallel, one of the said guides having been submitted to a rotation of an angle comprised between 45° and 90° with regard to the other and an intermediary member constituted by a prismatic cavity, or wave guide section, of which the right angled cross-section is a right-angled isosceles triangle, one of the rectangular guides being coupled to the cavity according to one of the sides of the right angle and the other according to a direction

2

making with the said side of the right angle an angle equal to the angle between the two rectangular guides.

Other objects, features and advantages of the present invention will appear from the following description of embodiments, the said description being given in connection with the accompanying drawings in which:

The Figures 1 and 2 represent different embodiments of wave guides using features of the invention, provided with; impedance matching devices and attenuation devices.

The Figure 3 represents a device introducing a rotation of the polarization plane between two rectangular guides and using a prismatic cavity of which the section is a right-angled isosceles triangle.

As there has been shown before, there is known the theoretical works for propagating electromagnetic waves in hollow metallic prisms of a given right angled cross-section filled with a dielectric. In particular extensive studies have been made of the cases corresponding to rectangular and circular cross-section, propagation of electromagnetic waves in hollow metallic prisms of triangular cross-sections having been the object only of partial studies primarily for transmission in the transverse magnetic mode, some of which are referred to above. The applicant has found that in a hollow metallic prism filled with dielectric, of which the right angled cross-section is a right-angled isosceles triangle, the Maxwell equations have a solution corresponding to the existence of a transverse electrical mode of propagation for which the expressions of the electric and magnetic fields have in a cartesian system of coordinates simple shapes with independent variables allowing in particular an easy computation of the phase wave length. In the case of a right angled cross-section having the shape of a right angled isosceles triangle a fundamental electric transverse mode may be defined as in a rectangular guide; its cut-off wave length is equal to the sum of the lengths of the sides of the right angles in the case of a dielectric constant equal to 1. In such a triangular wave guide, the cutting lines are constituted by the edge facing the greater side of the right-angled isosceles triangle and the median line of the greater side. It is then possible under these conditions to constitute a triangular angle by bringing together two 45° angle pieces, as it is shown in Figures 1, and 2, in which there has been indicated in 1 and 2 the cutting lines.

Study of the distribution of the electric field in the plane of the two cutting lines shows that the electric field varies from a maximum along the cutting line corresponding to the middle of the great side to zero for the cutting line along the edge corresponding to the top of the right angle. It results then from that in the vicinity of a slit along the cutting line corresponding to the middle of the great side, the electric coupling of a probe is a maximum while in the vicinity of a slit along the edge corresponding to the top of the right angle the coupling is very weak.

The Figure 1 represents schematically a screw impedance matching device comprising on the one hand a screw 20 in a slit 21 arranged along the edge corresponding to the top of the right angle, and, on the other hand, a screw 22 in a slit 23 provided according to the cutting line of the side facing the top of the right angle of the wave guide 24, the screw 22 constitutes a shunt susceptance varying rapidly while the screw 20 constitutes a vernier or trimmer control.

The same property is used in the Figure 2 for the realization of an attenuator of the guillotine type in a wave guide 25 of triangular section comprising two slits 26 and 27 along the two cutting lines. Metallic sheets 28 and 29 come through the slits 26 and 27 respec-

tively, the sheet 29 allowing a fast regulation of the attenuation while the sheet 28 allows a regulation of the vernier type.

There is represented in the Figure 3 a device using a triangular wave guide section according to this invention for effecting a rotation of the polarization plane of a guided electromagnetic wave in a rectangular right cross-section prism wave guide. There is shown at 30 a rectangular right cross-section wave guide of which the greater side is horizontal and at 31 a rectangular right angle cross-section wave guide of which the great side is vertical, the two sides being connected by means of a prismatic wave guide cavity 32 of which the section is a right-angled isosceles triangle and which is in tune for the transverse electrical mode. A screw 33 displayed on a line corresponding to the middle of the greater side of the triangular section permits adjustment of the impedance of this cavity to effect transfer of energy between 31 and 30, in a certain frequency band without noticeable reflection. The triangular cavity possesses a transverse electrical mode of vibration such that in a right angled cross-section the electric field is perpendicular to the side of the triangle on the contour and is a maximum in the middle of each side. It is thus possible under these conditions to realize coupling between the wave guides traversed by electric waves with polarization planes different from 45° or 90° or of an intermediary angle, the Figure 3 representing the case of the rotation of the plane of polarization of an angle equal to 90°. Such an arrangement allows to avoid the use of twisted rectangular guides, and, consequently, to reduce the bulk of the circuits necessitating such a rotation of the polarization plan of the transverse electric waves.

While the principles of the invention have been described above in connection with specific embodiments and particular modifications thereof, it is to be clearly understood that this description is made only by way of example and not as a limitation on the scope of the invention.

I claim:

1. A wave guide transmission system comprising an electrical wave guide having right angled cross section in the form of a hollow right angular isosceles triangle, whereby, during wave transmission, a maximum electrical field exists in the region corresponding to the median line along the surface of the prism facing the right angle, and a minimum electrical field exists in the region along a line at the apex of the ninety degree angle, an impedance adjusting unit positioned substantially on said

median line, adjustable to a variable extent into said hollow of said wave guide, further comprising an adjustable unit mounted on said wave guide at said apex, adjustable into said hollow in variable amounts to effect a small adjustment of the impedance of said wave guide, and a second and third wave guide section of rectangular cross-section, said sections being positioned with their longitudinal axes parallel, with said second and third sections in substantially contiguous relation with said first section at opposite ends thereof, said second and third sections being positioned with their transverse axes at an angle between forty-five and ninety degrees with respect to one another.

2. A wave guide transmission system, for rotating the plane of polarisation of a wave during transmission along said system, comprising a first hollow wave guide section having a transverse cross section in the form of a right angle isosceles triangle, second and third hollow wave guide sections each having transverse cross-sections of rectangular form, said sections being in a contiguous line with their longitudinal axes substantially parallel, said first section being positioned between said other two sections, said rectangular wave guides having corresponding transverse walls at an angle between forty-five and ninety degrees with respect to one another.

3. A wave guide system according to claim 2, further comprising an impedance adjusting means for said first section positioned substantially at the median line of the wall of said section opposite the right angle.

4. A wave guide system according to claim 2, wherein two walls of said second wave guide section at one of the angles of said rectangle are substantially contiguous with the right angular walls of said first section.

5. A wave guide system according to claim 4, wherein two walls of said third wave guide section at one of its angles are substantially contiguous with the right angular walls of said first section, and at ninety degrees with respect to corresponding walls of said second section.

6. A wave guide system according to claim 5, wherein the major axis walls of said second and third sections are substantially the same width as the right angular walls of said first section.

References Cited in the file of this patent

UNITED STATES PATENTS

2,147,717	Schelkunoff	Feb. 21, 1939
2,646,551	Roberts	July 21, 1953
2,684,469	Sensiper	July 20, 1954
2,736,867	Montgomery	Feb. 28, 1956