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Schüttlöffel

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[54] **WAVEGUIDE FOR SIMULTANEOUSLY TRANSMITTING TWO ELECTROMAGNETIC WAVES**

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** .... **333/95 A,** 333/95 R

[51] **Int. Cl.** **H01p 3/12,** H01p 3/14

[58] **Field of Search** .... 333/95 R, 95 A, 98

[56] **References Cited**

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[57] **ABSTRACT**

A flexible waveguide for the simultaneous transmission of two perpendicularly disposed linearly polarized electromagnetic waves. The waveguide is in the form of a hollow, elongated, thin-walled flexible metal body which has a constant cross-sectional profile along its longitudinal axis. The outer periphery of the cross-sectional profile is approximately quadratic with rounded corners and constitutes a continuous smooth curve free of abrupt changes in slope. The inner periphery of the cross-sectional profile defines the cross section of a longitudinally extending recess. The cross section of the recess is in the form of two, overlapping, identical ellipses having major axes which are perpendicular to one another.

8 Claims, 2 Drawing Figures

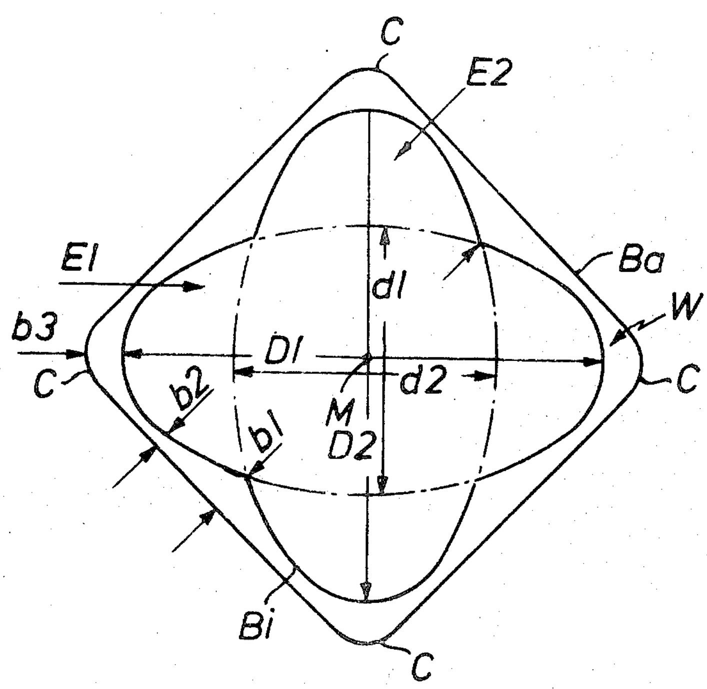
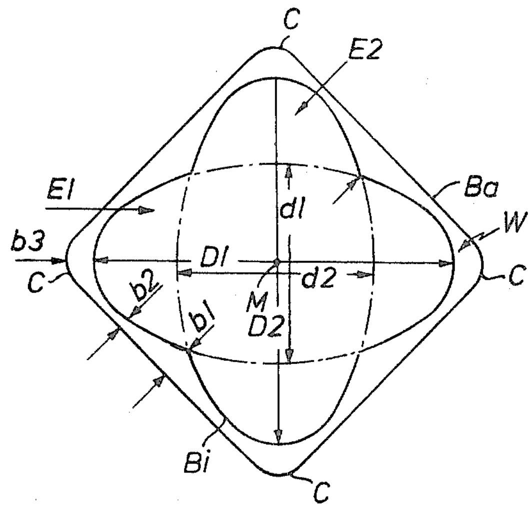


FIG. 1


C
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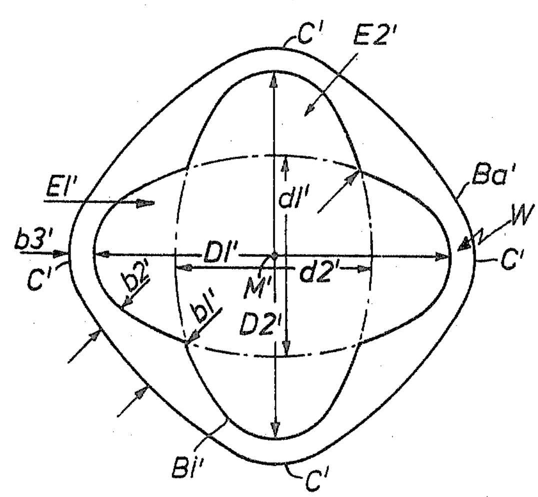
E1
Ba
W
b3
D1
d1
d2
C
M
b2
b1
D2
Bi
C

FIG. 2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Ba'
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C'
M'
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D2'
Bi'
C'

WAVEGUIDE FOR SIMULTANEOUSLY TRANSMITTING TWO ELECTROMAGNETIC WAVES

BACKGROUND OF THE INVENTION

This invention relates to a flexible waveguide for the simultaneous low-attenuation transmission of two linearly polarized electromagnetic waves. The present invention, more particularly, relates to a flexible, thin-walled waveguide for the simultaneous low-attenuation transmission of two linearly polarized electromagnetic waves in which the waves are transmitted through respective recesses of elliptical cross section.

The increasing demand for communications connections makes it necessary to utilize available directional antennas in multiple ways. In this regard it is known to transmit simultaneously two different data carrying electromagnetic waves over the antenna of a directional radio station, two distinct, perpendicularly polarized waves being used. To feed an antenna which is operated in such a manner two separated waveguide arrangements are normally required which are combined at the antenna via a suitable switching device operative for coupling the electromagnetic waves to the antenna.

It is also possible to transmit simultaneously two distinct, perpendicularly polarized electromagnetic waves through a circular waveguide.

Circular waveguide techniques and the principle of using dual power lines, however, are expensive, the former because of the required straight installation and the latter because of the need of using two separate waveguide arrangements with their associated switching device.

In a conventional waveguide with a quadratic cross section it is possible to transmit simultaneously two perpendicular polarized electromagnetic waves. The cost of such a waveguide feeder arrangement is still relatively high since a plurality of angle bends in the waveguide are required which are connected with the straight waveguide portions of the arrangement by means of flange connections. This produces undesirable reflection points. Moreover, this results in a significant electrical drawback for such a waveguide arrangement has a high attenuation when it is nonambiguous. Moreover, in a conventional quadratic waveguide for the simultaneous transmission of two perpendicularly polarized electromagnetic waves sufficient decoupling of the two polarizations can be attained only in that the quadratic cross section is produced or maintained, respectively, with the utmost precision. The same applies to conventional circular waveguide arrangements.

SUMMARY OF THE INVENTION

It is the object of the present invention to provide a flexible waveguide in which the above-described drawbacks are overcome.

This object, as well as others which will become apparent from the text below, is accomplished according to the present invention by providing a waveguide in the form of an elongated, hollow, thin-walled, flexible metal body having a constant cross-sectional profile along its longitudinal axis. The outer periphery of the cross-sectional profile is approximately quadratic with rounded corners and constitutes a continuous smooth curve free of abrupt changes in slope. The inner periphery of the cross-sectional profile defines the cross section of a longitudinally extending recess. The cross section of the recess is in the form of two, overlapping, identical ellipses having major axes which are perpendicular to one another.

The flexible metal tube may be made of aluminum.

The flexible metal body is preferably made of a relatively thin metal tube. The thin metal tube is preferably seamless and may be fabricated by conventional drawing techniques.

The identical ellipses whose major axes are perpendicular to one another preferably, simultaneously form the diagonals with respect to the outer quadratic cross-sectional periphery of the flexible metal body.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an end view of a first embodiment of a flexible waveguide according to the present invention.

FIG. 2 is an end view of a second embodiment of a flexible waveguide according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention, in the illustrated embodiment of FIG. 1 is in the form of an elongated, hollow metal body having a thin wall W. The outer periphery B*a* of the constant cross-sectional profile of the metal body forms approximately a quadratic structure, or i.e. square having four rounded corners C. The outer periphery Ba, therefore constitutes a continuous smooth curve since it is free of any abrupt changes or bends along its path. The inner periphery Bi of the cross-sectional profile of the waveguide is defined by two overlapping ellipses E1 and E2 which both have the same center point M. The elipses E1 and E2 are identical and are rotationally displaced by about 90° with respect to one another so that the inner recess of the waveguide corresponds approximately to the shape of a four-petal rosette. The major axis of the ellipse E1 is designated D1; the major axis of the ellipse E2 is designated D2. The two above-mentioned major axes D1 and D2 coincide with the diagonals of the approximate square which constitutes the outer periphery B*a* of the metal body. The minor axis of ellipse E1 is designated *d***1**. The minor axis of the ellipse E2 corresponds in length to the minor axis *d*1 and is designated d2.

The dimensions of the two ellipses E1 and E2 forming the inner cross section are such that the ratios of each of the minor axes *d*1 and *d*2 to the respective major axes D1 and D2 lie in a range between 0.55 and 0.85 and preferably are 0.65. The thickness of the thin waveguide wall W is so selected that the waveguide is characterized by sufficient flexibility with simultaneously sufficient rigidity in dependence on the material constants.

Preferably, the waveguide of the present invention, illustrated in FIG. 1, is produced in the form of a seamlessly drawn aluminum tube. As shown in FIG. 1, the thickness *b*3 of the waveguide wall in the vicinity of the rounded corners C of the outer periphery B*a* of the cross-sectional profile,i.e., in the vicinity of the major axes D1 and D2 of the two ellipses, is about 2 millimeters. In the vicinity of the intersections of the two ellipses E1 and E2, the wall thickness *b*1 is selected to be about 4 millimeters, while the wall thickness *b*2 in the space midway between the corners C of the outer periphery Ba of the quadratic cross-sectional profile and the intersections of the ellipses E1 and E2 is approximately 1 millimeter.

The present invention, in the illustrated embodiment shown in FIG. **2** is in the form of an elongated, hollow metal body having a thin wall W'. The outer periphery Ba' of the cross-sectional profile of the metal body again forms approximately a square having four rounded corners C'. The outer periphery Ba' constitutes a continuous smooth curve free of abrupt changes in slope. The inner periphery Bi' of the cross-sectional profile of the waveguide is defined by two overlapping ellipses E1' and E2' which both have the same center point M'. The ellipses E1' and E2' are identical and are rotationally displaced by about 90° with respect to one another so that the inner recess of the waveguide corresponds approximately to the shape of a four-petal rosette. The major axis of the ellipse E1' is designated D1'; the major axis of ellipse E2' is designated D2'. The two above-mentioned major axes D1' and D2' coincide with the diagonals of the approximated square which constitutes the outer periphery Ba'. The minor axes of the ellipses E1' and E2' are respectively designated *d*1' and *d*2'.

The dimensions of the two ellipses E1' and E2' forming the inner cross section are such that the ratios of each of the minor axes *d*1' and *d*2' to the respective major axes D1' and D2' lie between 0.55 and 0.85 and preferably are 0.65. The thickness of the waveguide wall W' is so selected that the waveguide receives sufficient flexibility with simultaneously sufficient rigidity in dependence on the material constants.

In the preferred embodiment of the present invention shown in FIG. **2**, the outer, approximately square cross-sectional profile Ba' is so designed that the surfaces between the rounded corners C' are symmetrically outwardly curved.

Preferably, the waveguide of the present invention, as shown in FIG. **2**, is produced in the form of a seamlessly drawn aluminum tube. The thickness *b*3' of the waveguide wall in the area of the rounded corners C' of the outer periphery Ba' of the cross-sectional profile, i.e. in the vicinity of the major axes D1' and D2' of the two ellipses, is about 1 millimeter. In the vicinity of the intersections of the two ellipses E1' and E2', the wall thickness *b*1' is selected to be about 5 millimeters, while the wall thickness *b*2' in the space midway between the corners C' of the outer approximately quadratic periphery Ba' and the intersections of the ellipses E1' and E2' is approximately 2 millimeters.

A waveguide constructed according to the present invention can be manufactured in long lengths in a continuous fabrication process. The waveguide permits the simultaneous transmission of two perpendicular waves in such a manner that in spite of bending and/or twisting of the waveguide there is maximum mutual decoupling. The previously required switching devices as they were discussed in the introduction to this specification are thus eliminated.

It will be understood that the above description of the present invention is susceptible to various modifications, changes and adaptations, and the same are intended to be comprehended within the meaning and range of equivalents of the appended claims.

I claim:

1. A flexible waveguide for the simultaneous transmission of two perpendicularly disposed linearly polarized electro-magnetic waves comprising an elongated, hollow, thin-walled, flexible metal body having a substantially constant cross-sectional profile along its longitudinal axis, the outer periphery of said cross-sectional profile being approximately quadratic with rounded corners and constituting a continuous smooth curve, free of abrupt changes in slope; and the inner periphery of said cross-sectional profile defining the cross-section of a longitudinally extending recess, in the form of two, overlapping, identical ellipses having their major axes perpendicular to one another.

2. A flexible waveguide as defined in claim **1** wherein said major axes coincide with the diagonals of said outer periphery of said cross-sectional profile.

3. A flexible waveguide as defined in claim **2** wherein said flexible metal body comprises a seamless metal tube.

4. A flexible waveguide as defined in claim **1** wherein the ratio of the minor axis to the major axis of each ellipse is in a range from substantially 0.55 to substantially 0.85.

5. A flexible waveguide as defined in claim **4** wherein said ratio is substantially 0.65.

6. A flexible waveguide as defined in claim **1** wherein said outer periphery of said cross-sectional profile between said corners is symmetrically outwardly curved.

7. A flexible waveguide as defined in claim **1** wherein the thickness of the wall of said flexible metal body in the vicinity of said corners is approximately 2 millimeters, in the vicinity of the intersections of the two ellipses is approximately 4 millimeters and in the space substantially midway between said corners and said intersections is approximately 1 millimeter.

8. A flexible waveguide as defined in claim **3** wherein said flexible metal body comprises a seamless, drawn, aluminum tube.

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