United States Patent

[11] **3,577,105**

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[73] Assignee **The United States of America as represented by the Secretary of the Army**

[54] **METHOD AND APPARATUS FOR JOINING PLATED DIELECTRIC-FORM WAVEGUIDE COMPONENTS**
10 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** **333/95,** 333/98, 333/35, 287/64, 287/103
[51] **Int. Cl.** **H01p 1/04,** H01p 3/12, F16b 7/00
[50] **Field of Search** ..... 333/95, 98, 35; 29/600, 601; 174/91—92; 287/64, 103; 156/48—49

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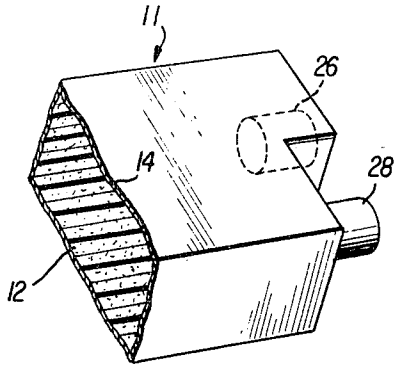
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ABSTRACT: A plated dielectric waveguide component which includes a dielectric foam substrate propagating medium and a thin metallic surface encapsulating the substrate for carrying a conducting current therealong and a method of interconnecting the same. The waveguide component has a quarter wavelength step-shaped end which may be readily butt joined with another plated dielectric waveguide component having a similar construction and matching end whereby a lightweight, sturdy and highly efficient connection is obtained.



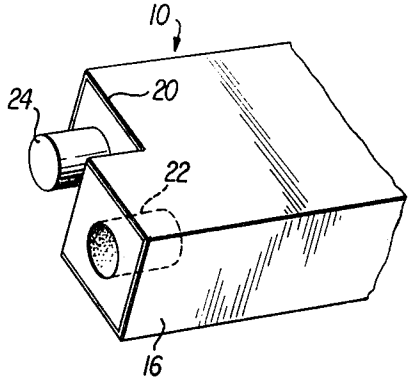


FIG. 1

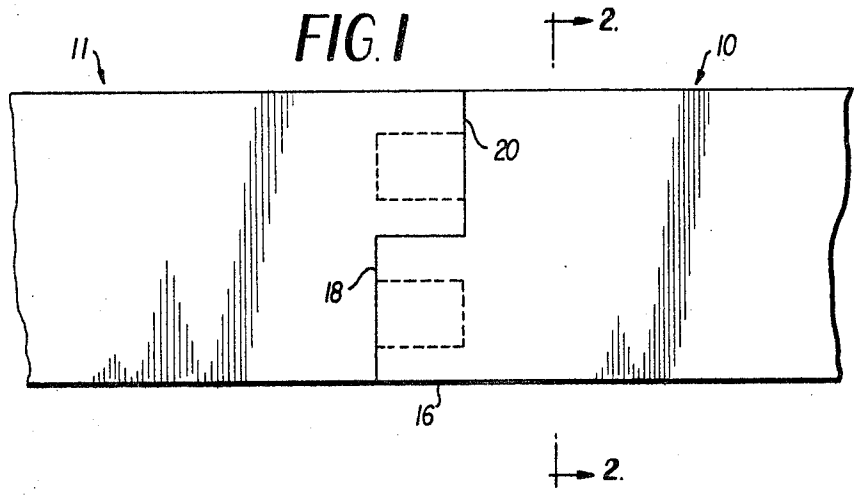
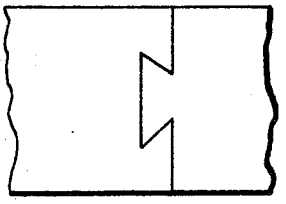


FIG. 4



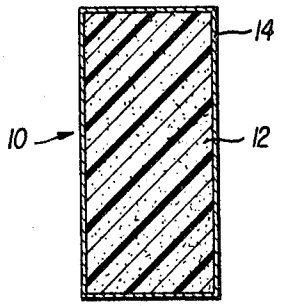


FIG. 2

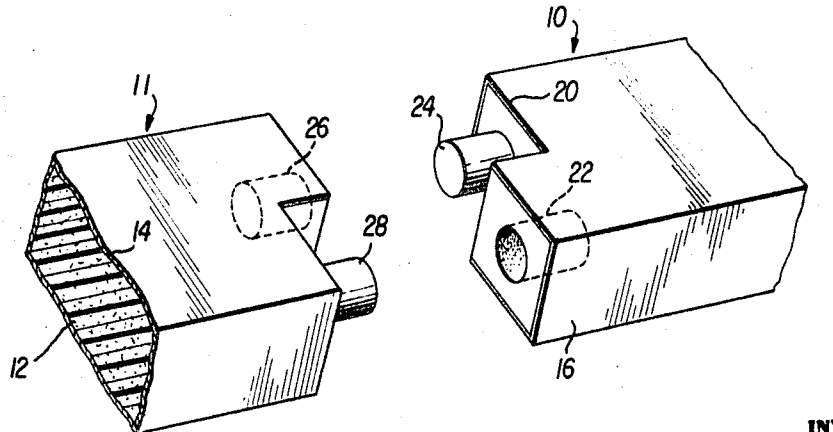


FIG. 3

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METHOD AND APPARATUS FOR JOINING PLATED DIELECTRIC-FORM WAVEGUIDE COMPONENTS

BACKGROUND OF THE INVENTION

This invention relates generally to plated dielectric-foam waveguide components and more particularly to a unique method and apparatus for the interconnection of plated dielectric-foam waveguide components.

In the past, the weight and bulk of most waveguide systems stemmed from their use of metal waveguides and flanges with thick walls. The standard waveguide components used in such systems were generally made of brass or copper-alloy tubing having a wall thickness of 0.125 to 0.025 inches. Some weight reduction was found possible with the use of aluminum and magnesium guides, but these were found to be quite expensive. In addition, further weight reduction could be obtained by properly designing the waveguide components for minimum volume and by fabricating the same as a complete system by milling, dip brazing, electroforming or investment casting.

Understanding that the thick wall of a standard air-filled waveguide, as discussed above, is essential only for rigidity, since the current of a propagating wave is concentrated in a very thin layer (10^{15} to 10^{12} cm.) on the inner wall surface, there has recently been developed a waveguide component which uses a low-loss, rigid dielectric substrate as the propagating medium, rather than air. With such a dielectric substrate, the need for use of a thick waveguide wall becomes unnecessary. Instead, a thin metallic surface (approximately 0.005 inches) encapsulating the dielectric substrate is sufficient to carry the conducting current. Such a plated dielectric waveguide component has proved to be much lighter than that of the previously discussed standard metal waveguide and is also cheaper to make.

Interconnections between various waveguide components of both the standard metal type and the recently developed plated dielectric type have in the past been accomplished by the use of flange elements at the respective ends of the waveguide components to be connected. In each instance, a plain flange and a quarter wave choke flange would be used to provide the necessary connection between the waveguide components. Ordinarily at the discontinuity between the two interconnected waveguide components standing waves and reflections would occur due to a mismatch in the electrical energy flowing from one waveguide component to the other. The use of the back-to-back quarter wave choke flange and the plain flange were found to be somewhat satisfactory in improving the above-mentioned mismatch by minimizing the reflections and standing waves set up at the discontinuity and there reduce losses caused by the same. However, the flange elements having a larger cross section than that of the waveguide components themselves were heavy, bulky and expensive and required the use of a quarter wave matching choke. Moreover, with the plated dielectric-type waveguide, the plated foam flanges were very delicate and generally required a metal insert for reinforcement.

SUMMARY OF THE INVENTION

Accordingly, one object of the present invention is the provision of a new and improved plated dielectric-type waveguide component.

Another object of this invention is the provision of a new and improved plate dielectric-type waveguide component which is lightweight and easy to construct.

A further object of this invention is the provision of a new and improved plated dielectric-type waveguide component which may be readily interconnected with other waveguide components.

Still another object of the subject invention is to provide a new and improved unique plated dielectric-type waveguide component which is capable of joinder with other waveguide components to provide a better matched connection than heretofore existed and at the same time, eliminate the need for flange elements.

Yet another object of the instant invention is the provision of a new and improved plated dielectric waveguide component which may be readily interconnected with other waveguide components to give a connection of the same cross section as that of the waveguide component itself.

Yet still another object of this invention is the provision of a new and improved method of interconnecting plated dielectric-type waveguide components.

One other object of this invention is the provision of a new and improved method for interconnecting a plated dielectric-type waveguide component which has a step-shaped end portion which may be readily aligned with a similar step-shaped end of another waveguide component to provide a low-loss butt joint connection.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete appreciation of the invention will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

FIG. **1** is a side view of an interconnection between two plated dielectric waveguide components according to the present invention;

FIG. **2** is a cross-sectional view taken along the lines **2–2** of one of the waveguide components of FIG. **1**;

FIG. **3** is a perspective view of one embodiment for interconnecting plated dielectric waveguide components in accordance with the present invention; and

FIG. **4** is a side view of still another manner for interconnecting the plated dielectric waveguide components in accordance with the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings wherein like reference numerals designate identical or corresponding parts throughout the several views, and more particularly to FIG. **1** thereof wherein a waveguide component in accordance with the present invention is shown as having a step-shaped end connecting portion **16** which includes an extending portion **18** and a recessed portion **20**. The waveguide component **10** may be readily joined with another waveguide component **11** which has a similarly shaped end portion which may be butt joined to the waveguide component **10**. The step-shaped portion is preferably of a quarter wave length and as such will provide a low-loss connection and thereby allow the energy from one waveguide component to propagate to the other waveguide component with very little reflections or standing waves present. If a permanent joint is desired, the two respective end portions of the waveguide components **10** and **11** may be sealed by the use of any conventional conductive adhesive, such for example as the type provided by Emerson and Cumming or Dupont.

FIG. **2** shows a cross-sectional view taken along the lines **2–2** of the waveguide component **10** at FIG. **1**. The cross-sectional view shows the waveguide **10** having a dielectric substrate **12** and a thin metallic outer surface **14** encapsulating the substrate. The dielectric substrate **12** is used as the waveguide propagating medium and may be any of several solid or foam dielectrics, such for example as polystyrene, styrofoam, polyurethene foam or the like. The thin metallic surface **14** encapsulating the substrate **12** may be of any conductive material, such for example as copper or silver. A more detailed description of the dielectric substrates and encapsulating metallic surfaces, as well as the manner of plating the same, may be obtained from the article in Microwaves, July, 1965, entitled "Plated-Dielectric Waveguide Components" by Howard S. Jones and Richard A. Norris.

Referring now to FIG. 3, an alternative embodiment for interconnecting the waveguide components 10 and 11 according to the present invention is therein shown. In particular, an aperture such for example as the aperture 22, in the extending dielectric portion 16 of the waveguide component 10 and a post, such for example as the post 24, protruding from the recessed dielectric portion 20 of the same waveguide component 10 is provided for facilitating a butt joint connection with another waveguide component. For example, waveguide component 11 is shown as including in a similar fashion an aperture 26 and a post 28 in such a manner that the two waveguide components 10 and 11 may be readily aligned and interconnected. With such a connection the need for a permanent seal may be eliminated so that the waveguide components may be readily disconnected for other use. Moreover, it should be understood that while the apertures and posts have been shown as being of the dowel type that other connecting elements may be readily used. For example, the aperture and posts could be of the tongue and groove type, as illustrated in FIG. 4.

It should now be apparent that the plated dielectric waveguide component of the herein described invention allows for interconnection of the same with other similar waveguide components in a low-loss, lightweight and efficient manner. Moreover, it should be apparent that with the step-shaped connection according to the hereinabove described invention, the cross section of the connection is the same as that of the component itself and thereby both conserves space and reduces cost.

I wish it to be understood that I do not desire to be limited to the exact details of construction shown and described, for obvious modifications will occur to a person skilled in the art.

I claim:

1. A plated dielectric waveguide component comprising:

a dielectric substrate as a propagating medium,

a thin metallic surface encapsulating said substrate for carrying a conducting current therealong, and

wherein said waveguide component formed of said combination dielectric substrate and thin metallic surface has at least one step-shaped end for allowing a butt joint interconnection with another waveguide component having a similarly shaped end.

2. A plated dielectric waveguide component as in claim 1 wherein said step-shaped end is of a quarter wavelength.

3. A plated dielectric waveguide component as in claim 1 wherein said butt joint interconnection is made permanent by use of a conductive sealer.

4. A plated dielectric waveguide component as in claim 2 wherein said dielectric substrate is a low-loss dielectric foam.

5. A plated dielectric waveguide component as in claim 4 wherein said thin metallic surface is copper.

6. A plated dielectric waveguide component as in claim 2 wherein said step-shaped end includes an extending portion having an aperture therein and a recessed portion having a post attached thereto whereby said butt joint interconnection with another waveguide component having a similarly shaped end is facilitated by allowing the respective posts and apertures to be aligned and interconnected.

7. A plated dielectric waveguide component as in claim 6 wherein said aperture and post are formed out of said substrate which is a dielectric foam.

8. A plated dielectric waveguide component as in claim 6 wherein said aperture and post are respectively a groove and tongue.

9. A plated dielectric waveguide component as in claim 6 wherein said aperture and post are of the dowel type.

10. A plated dielectric waveguide component as in claim 6 wherein said butt joint interconnection is sealed by the use of a conductive sealer.