

[54] **VERSATILE IN LINE WAVEGUIDE TO COAX TRANSITION**

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[51] Int. Cl. **H01p 5/08, H01p 1/00**

[58] Field of Search **333/21 R, 33-35, 333/97 R**

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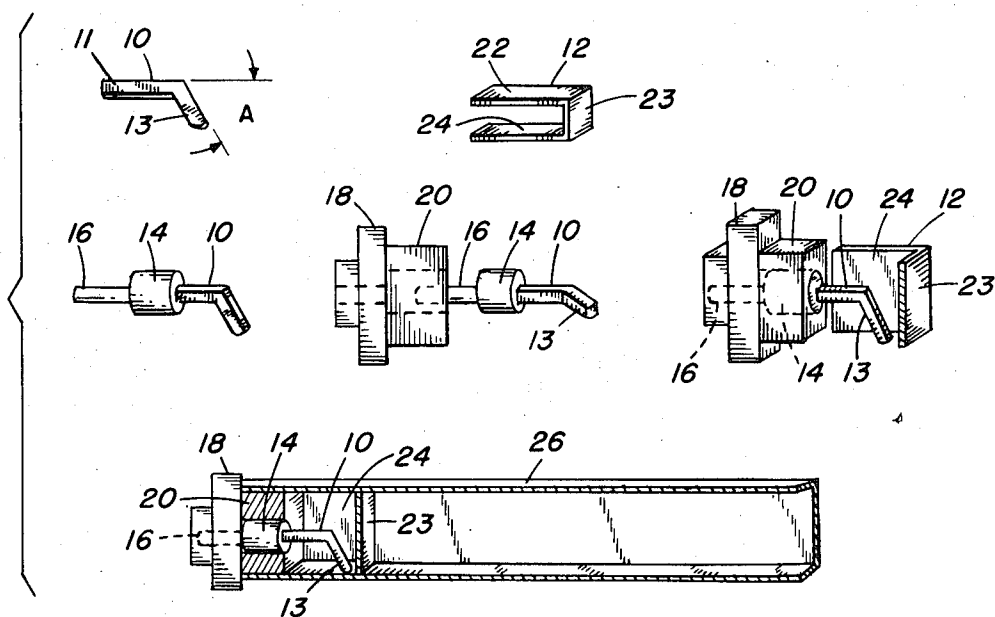
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[57] **ABSTRACT**

A microwave transition to interface between a coaxial cable and a waveguide comprises a hook-shaped exciter and a U-shaped dielectric loading transformer. The exciter is an extension of the inner conductor of the coaxial line. It enters the waveguide along its longitudinal axis and bends toward the top or bottom wall of the waveguide. The transformer surrounds the exciter with the open end located at the waveguide-coax interface.

9 Claims, 2 Drawing Figures



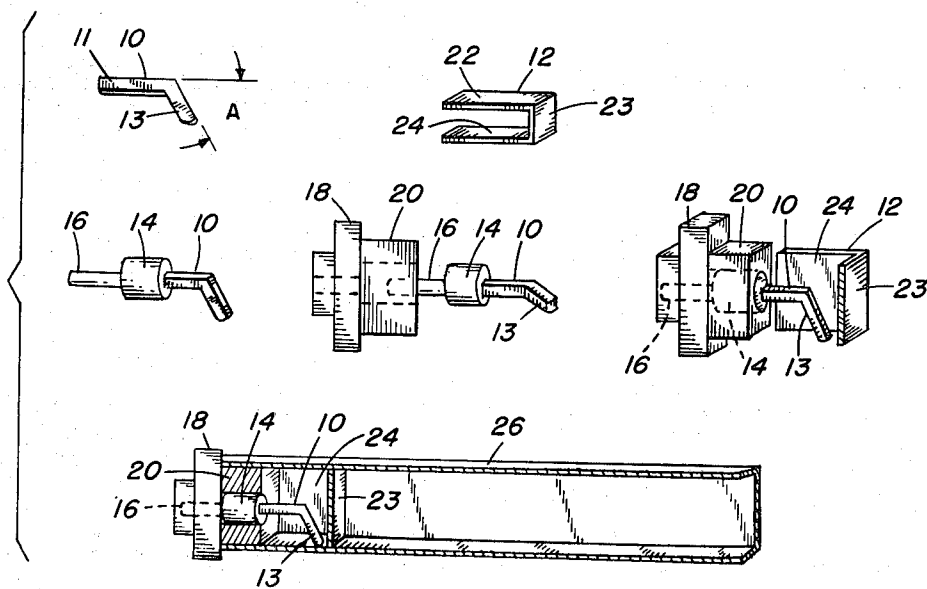


FIG. 1

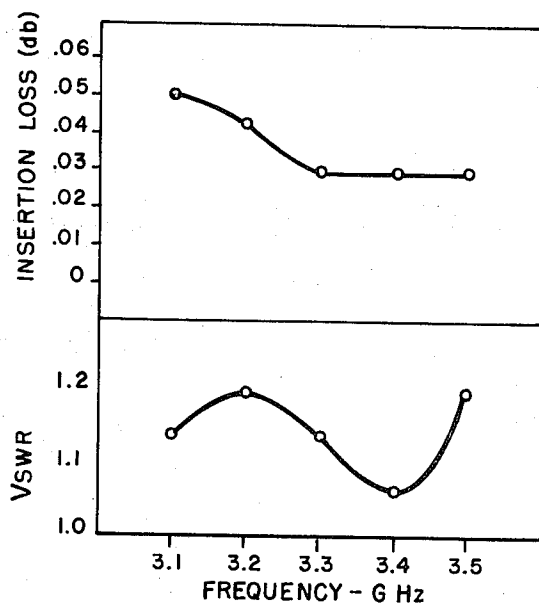


FIG. 2

VERSATILE IN LINE WAVEGUIDE TO COAX TRANSITION

BACKGROUND OF THE INVENTION

The present invention relates generally to the coupling of electromagnetic energy and more particularly to the coupling of RF energy from a coaxial line into a waveguide.

One of the most difficult problems involved in the transmission of RF energy is suitably coupling RF energy into or out of a waveguide type structure from a coaxial transmission structure. Various design considerations in RF systems often demand the use of waveguide type transmission means in some parts of the system and coaxial transmission means in other parts. The necessity of coupling RF energy from one to the other arises as a result. The problem is especially serious when coupling into a heavily loaded waveguide section.

SUMMARY OF THE INVENTION

The present invention is concerned with coupling RF energy from a coaxial cable into a waveguide. The transition consists of a hook shaped exciter surrounded by a U-shaped dielectric loading transformer. The exciter is connected to the inner conductor of the coaxial cable and extends into the waveguide along its longitudinal axis. The transformer surrounds the exciter with the open end located at the waveguide-coax interface.

OBJECTS OF THE INVENTION

An object of the present invention is to provide a coax-to-waveguide transition which is of simple design and construction.

Another object of the present invention is to provide a means for coupling RF energy from a coaxial cable to a waveguide having good electrical performance in terms of VSWR and insertion loss.

A further object of the invention is to provide an RF phase shifter in which a coax-to-waveguide transition is assembled as an integral part thereof.

Still another object of the invention is to provide a coax-to-waveguide transition which can be produced in large quantities at low cost and which can be miniaturized to result in small size, light weight and minimum volume.

Other objects, advantages and novel features of the present invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows the preferred embodiment of the invention in various stages of assembly for connection into a phase shifter.

FIG. 2 shows experimental results achieved with an embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1, which illustrates a preferred embodiment of the invention, shows hook-shaped exciter 10 and U-shaped dielectric loading transformer 12. As can be seen in FIG. 1, the exciter 10 has a shank portion 11 and a portion 13 extending at an angle A from the shank portion and is of square or rectangular cross-section. This results in both electrical and mechanical

advantages over a similar circular cross-section exciter. The capacitive reactance between the exciter and the side walls of the transformer, necessary for impedance matching, is more readily achieved with the square cross-section. In addition, the manufacturing process of stamping out exciters of square cross-section is much faster and more economical than bending circular cross-section exciters, especially in large production runs. The dielectric transformer 12 is a U-shaped block of dielectric material which surrounds the exciter with the open end located at the waveguide-coax interface. The transformer has two side walls 22 and 24 and a base 23. The shank 11 of exciter 10 fits into an insulative spacer 14. A connector fitting 18 of conducting material has a central opening through which an extension 16 of the center conductor of the coaxial cable extends.

Dielectric transformer 12 is disposed within the waveguide 26 with side walls 22 and 24 parallel to the side walls of the waveguide. The geometric center of base 23 is coincident with the longitudinal axes of the waveguide. The transformer fits snugly against spacer 14 and connector body 20 with its open end facing the connector. Connector body 20 is metallic, completely surrounds spacer 14 and nearly fills the cross-section of the waveguide. The height of the transformer (that is, the vertical dimension of side walls 22 and 24) corresponds to the height of the waveguide. Thus, the top and bottom walls of the waveguide are in contact with the end surfaces of side walls 22 and 24 and the end surfaces base 23. The width of the transformer is determined primarily by the width of the exciter 10. The exciter extends into the waveguide at the geometrical center of the waveguide cross-section along the longitudinal axes thereof and is disposed between the side walls of the transformer. The side surface of the exciter are very close to but not in contact with the inner surfaces of transformer side walls 22 and 24. Likewise, the base 23 of the transformer is very close to but not in contact with the end of portion 13 of the exciter. Portion 13 is disposed downwardly and is in contact with the bottom wall of the waveguide. If the transition is to be integral with the waveguide section, the end of exciter portion 13 may be attached to the bottom wall of the waveguide. The angle A, formed by the exciter portion 13 and the longitudinal axes of the waveguide, lies in a plane which is parallel to transformer side walls 22 and 24.

The transition provides efficient transfer of RF energy from a coaxial transmission line to a heavily loaded waveguide. The loaded waveguide can be, for example, reduced size transmission line such as ridged waveguide or microwave components such as phase shifters. Transition units designed in accordance with the principles of this invention have been constructed to interface between the outputs of a 32:1 coaxial power divider and 32 waveguide phase shifters, all of which make up a small segment of a large phased array radar system. The physical dimensions of the exciter and transformer are a function of the operational bandwidth and the degree of loading necessary in the waveguide to lower the cut-off frequency to the desired value. A typical S-band phase shifter design results in the following transition dimensions: The waveguide size is reduced from the standard 3×1.5 inches to a guide size of 0.75×0.50 inch; the exciter length is approximately 0.640 inch; angle A is approximately 60° ;

the transformer is made from a material having a dielectric constant of 30 and wall thickness of approximately 0.090 inch and a spacing between inner walls of 0.160 inch. The electrical results of this design are shown in FIG. 2. The frequency bandwidth is 12 percent where the VSWR is less than 1.2 to 1 and the insertion loss is comparable to a coaxial line of the same dimensions. The transition was successfully high power tested to a level of 9KW peak power at s-band. The peak power level was limited to this value by two APC-7 connectors which were in the circuit at the time of the tests.

Obviously, many modifications and variations of the present invention are possible in light of the above teachings. For example, hook portion 13 of the exciter could contact the top wall of the waveguide. It is therefore to be understood that, within the scope of the appended claims, the invention may be practiced otherwise than do specifically described.

What is claimed is:

1. A coaxial line-to-waveguide transition comprising: a hook-shaped RF exciter of conductive material; and, a U-shaped dielectric loading transformer substantially surrounding the exciter.
2. The transition of claim 1 wherein the exciter is of rectangular cross-section.
3. The transition of claim 2 wherein: the exciter has a shank portion and a second portion extending at an angle to said shank portion; the transformer has two side walls and a base; the exciter is disposed within the transformer with the shank portion perpendicular to said base at the

geometrical center thereof; and, said angle lies in a plane which is parallel to the side walls.

4. The transition of claim 3 wherein:

the shank portion of the exciter is connected to the center conductor of the coaxial line; and, the dielectric transformer is disposed within the waveguide at one end thereof with the geometrical center of the base of the transformer being coincident with the longitudinal axis of the waveguide.

5. The transition of claim 4 wherein:

the dielectric transformer is disposed within the waveguide with its sidewalls parallel to the vertical walls of the waveguide; and,

the second portion of the exciter is in contact with the bottom wall of the waveguide.

6. The transition of claim 5 wherein the second portion of the exciter is connected to the bottom wall of the waveguide.

7. The transition of claim 5 wherein the end surfaces of the sidewalls and base of the transformer are in contact with the top and bottom walls of the waveguide.

8. The transition of claim 7 wherein:

the shank portion of the exciter lies at the geometric center of the waveguide cross-section along the longitudinal axis thereof; and,

the second portion of the exciter lies at an angle of approximately 60° with respect to the longitudinal axis of the waveguide.

9. The transition of claim 8 wherein the waveguide is a heavily loaded microwave phaseshifter.

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