

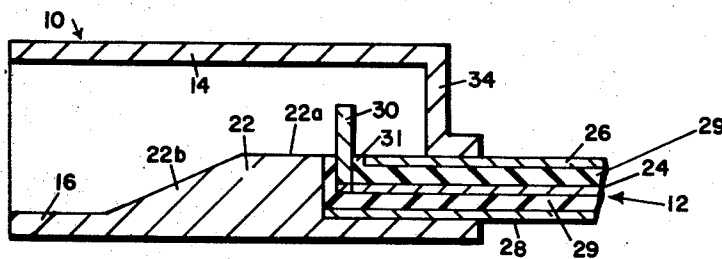
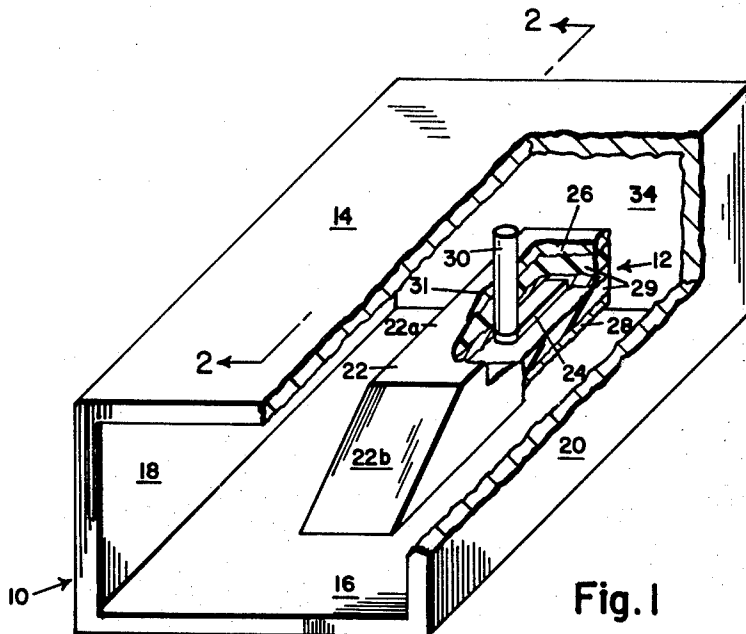
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STRIP LINE TO RIDGED WAVEGUIDE TRANSITION HAVING
A PROBE PROJECTING INTO WAVEGUIDE THROUGH RIDGE

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STRIP LINE TO RIDGED WAVEGUIDE TRANSITION HAVING A PROBE PROJECTING INTO WAVEGUIDE THROUGH RIDGE

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This invention relates to the art of high frequency transmission lines. More particularly, it relates to an improved transition for coupling high frequency energy between a waveguide and a transmission line. The transition utilizes a section of ridged waveguide to achieve extended bandwidth and suppress unwanted modes and, at the same time, provide an in-line arrangement that minimizes the space requirement.

It is a principal object of my invention to provide an improved waveguide-transmission line transition operable over a broad frequency band.

Another object of my invention is to provide a transition of the above type in which high order modes of energy propagation are effectively suppressed.

A further object of my invention is to provide a transition having the above characteristics that is easy to fabricate.

A still further object is to provide a waveguide-transmission line transition having a compact in-line construction.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the features of construction, combination of elements and arrangement of parts which will be exemplified in the construction hereinafter set forth, and the scope of the invention will be indicated in the claims.

In general, a transition embodying features of my invention combines a ridged waveguide with a transmission line that extends longitudinally into the ridge. One of the transmission line inner conductors projects from within the ridge into the guide, while the other conductor is connected to the metallic waveguide enclosure. An important advantage of this construction is its "in-line" form. The transverse dimensions of the transition are not greater than that of either the waveguide or the transmission line alone, and, therefore, the space requirement of the transition is at a minimum. The transition is particularly well adapted for use with strip transmission line. An additional advantage is the greater bandwidth that is obtained because the waveguide in the transition region is ridged, since this results in a lower waveguide impedance nearer the strip transmission line impedance, and the impedance is more nearly constant with frequency than for ordinary rectangular waveguide. Other advantages of my invention are set forth below.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings, in which:

FIGURE 1 is a perspective view, partly cut away, of a transition embodying the features of my invention, and

FIGURE 2 is a longitudinal section taken along the plane 2-2 of the transition of FIGURE 1.

As seen in the drawings, my transition includes a rectangular waveguide generally indicated at 10, disposed in line with a transmission line generally indicated at 12. The waveguide 10 has a pair of wide walls 14 and 16 and a pair of narrow walls 18 and 20, as well as a longitudinal ridge 22 projecting from wall 16 midway between the walls 18 and 20.

Transmission line 12 may be a strip line that comprises a flat, ribbon-like inner conductor 24 disposed symmetrically within an outer conductor system that comprises a pair of parallel ground plane conductors 26 and 28. The inner and outer conductors are spaced apart by insulators 29. The line forms part of the ridge 22. More specifically, the conductor 26 forms part of the upper surface 22a of the ridge 22. While a separate member may be used on this surface, the illustrated arrangement is preferred because it is considerably easier to assemble. The conductor 28 is in contact with the waveguide wall 16. A probe 30, preferably cylindrical, projects from the inner conductor 24 into the waveguide through an aperture 31. The probe is preferably disposed midway between the narrow walls 18 and 20.

The coupling phenomenon in the transition is similar to that of other couplers incorporating a probe. Thus, assuming propagation of energy to the left (FIGURE 2) along the transmission line 12, the potential gradient along the probe 30 induces a potential difference between the waveguide walls 14 and 16. Current on the probe 30 generates a magnetic field radiating concentrically from it. The magnetic field and the electric field extending between the walls 14 and 16 form an electromagnetic wave within the waveguide 10.

A conducting plate 34 terminates the waveguide 10 with a low impedance at roughly a quarter wavelength, at the operating frequency, from the probe 30. Because of the quarter-wavelength spacing, the low impedance of plate 34 appears as a high impedance at the probe. The waveguide 10 extending to the left from the probe, however, presents a relatively low impedance at the probe, assuming a matched condition, and, therefore, substantially all the energy is coupled to the waveguide and propagated to the left therein.

The probe 30 presents a reactive impedance component in the waveguide, the magnitude of which varies with the diameter and length of the probe. This may be compensated in a well-known manner by adjusting the position of plate 34 from an exact quarter-wavelength position, to introduce a reactive component which substantially cancels the reactance of the probe.

The transition is a reciprocal device, i.e., energy propagation to the right (FIGURE 2) in a TE_{10} mode in the waveguide excites a TEM mode propagating to the right in the strip transmission line 12.

By having the transmission line 12 extend into the rectangular waveguide 10, an improved transition having a compact, in-line construction is achieved. This improved construction is attained with substantially no reflecting discontinuities by enclosing the protruding transmission line within the waveguide ridge 22. The ridge increases the waveguide cut-off wavelength and increases the frequency range over which only the dominant TE_{10} mode will propagate in the waveguide without substantial attenuation. Thus, the transition has a broad frequency range and suppresses high order transmission modes without requiring a large or complex structure. Impedance matching between the waveguide and the transmission line is further enhanced by the inclined surface 22b, which provides a gradual tapered transition from the rectangular to ridged waveguide.

Although transmission line 12 is described as a strip line, it may also take other forms. For example, it may be a coaxial line having a cylindrical inner conductor and an outer conductor system in the form of a cylindrical tube coaxially enclosing the inner conductor.

Thus, I have described an improved microwave transition for coupling electromagnetic energy between a waveguide and a transmission line, particularly a strip or coaxial line. The waveguide is formed with a longitudinal ridge in the transition. The transmission line

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is fully recessed within the ridge with the inner conductor extending from the ridge into the waveguide. By combining the advantages of ridged waveguide with this construction, I have provided a transition in which the waveguide and transmission line may be arranged in a compact in-line configuration. Furthermore, the transition has a broad bandwidth, and unwanted transmission modes in the transmission line and in the waveguide are effectively suppressed.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained and, since certain changes may be made in the above construction without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

What is claimed is:

1. A waveguide-transmission line transition comprising, in combination, a waveguide having a rectangular cross section, a conducting plate terminating a first end of said waveguide with a low impedance, a ridge of conducting material protruding from a first wide wall of said waveguide, and extending along said wall from said plate, a transmission line having an outer conductor system and an inner conductor in which said outer conductor system comprises two ground plane outer conductors and in which said inner conductor is disposed equi-distantly between said ground plane outer conductors, said line protruding through said plate and being recessed within said ridge and in line therewith, a stud-type probe connected to said inner conductor and projecting from said ridge perpendicular to said first wall, means insulating said probe from said ridge, said plate being so located with respect to said probe as to present a high impedance at said probe at the operating frequency of said transition, said ridge providing an increase in waveguide cutoff wavelength while increasing the frequency range over which only a dominant mode will propagate in said waveguide.

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2. A waveguide-transmission line transition comprising, in combination, a waveguide having first and second wide walls and a pair of narrow walls, an end on said waveguide, a ridge in said waveguide extending from said end along said first wall, a strip transmission line comprising an inner conductor disposed between first and second ground plane conductors, said first ground plane conductor extending through said end of said waveguide to form a portion of a first surface of said ridge facing said second wall, means connecting said second ground plane conductor to said waveguide structure, means forming an aperture in said first surface of said ridge, a stub-type probe connected to said inner conductor and extending through said aperture into said waveguide, said probe being perpendicular to said wide walls, and low impedance means closing said end of said waveguides, said first surface of said ridge being substantially parallel to said first and second walls, said ridge including a sloping second surface adjoining said first surface and extending longitudinally of said waveguide and from said first surface to said first wall, said ridge providing an increase in waveguide cutoff wavelength while increasing the frequency range over which only a dominant mode will propagate in said waveguide.

3. The combination defined in claim 2 in which said ridge is located intermediate said pair of narrow walls and has a width less than the width of said waveguide.

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