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COUPLINGS BETWEEN WAVEGUIDES AND COAXIAL LINES

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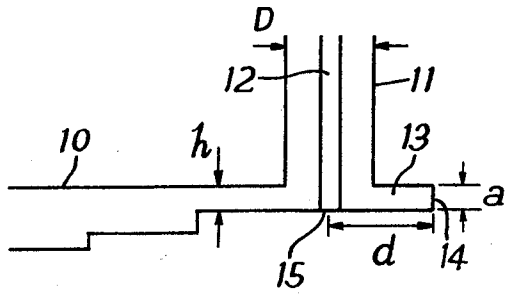


Fig. 1.
PRIOR ART

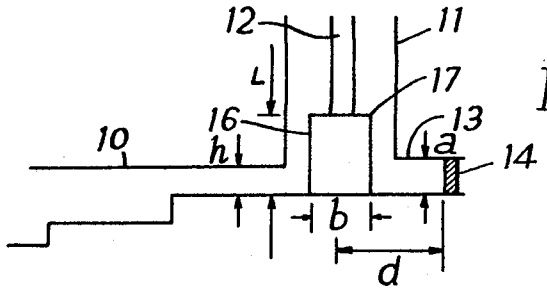


Fig. 2.

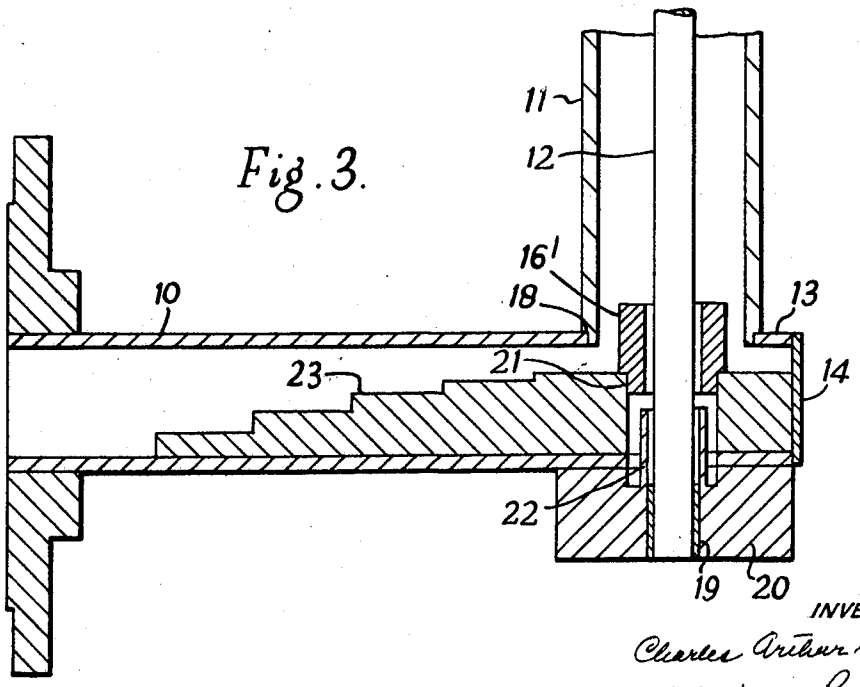


Fig. 3.

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ABSTRACT OF THE DISCLOSURE

In coaxial line to waveguide couplings in which the inner coaxial conductor extends across the interior of the waveguide to terminate on one broad wall of the waveguide, it is known to provide the inner conductor with an enlarged terminal portion to reduce the possibility of voltage breakdown and/or to assist in impedance tapering. The present invention provides for the enlarged portion to be longer than the width of the waveguide and thus to extend into the coaxial line outside the waveguide, giving considerably increased band width.

The present invention relates to couplings between waveguides and coaxial lines.

Such couplings are usually required to act as transformers to match the impedance of the waveguide, for example 380 ohms, to that of the coaxial line, for example 60 ohms. An example of a well known form of coupling is shown in FIG. 1 of the accompanying drawings. Here a rectangular waveguide **10** is coupled to a coaxial line **11** having a centre conductor **12**. In order to achieve matching, the narrower dimension of the waveguide is reduced in a series of steps to a value *h* such as to give the required waveguide impedance. This results in a voltage standing wave ratio (VSWR) that is higher than desirable for some purposes. The reduction in the narrower waveguide dimension is sometimes effected by tapering instead of in steps. The end of the centre conductor **12** is fixed to a broad wall of the waveguide at **15**.

A short section of rectangular waveguide **13** having a narrower dimension *a*, which need not necessarily equal *h*, is provided to act as a back cavity. The dimension *d* from the axis of the centre conductor **12** to the short circuit face **14** of the back cavity is adjusted for optimum match at the required frequencies while the bandwidth of the coupling is determined largely by the dimension *a*. Experience has shown that this dimension *a* should be such that the impedance of the back cavity **13** is approximately equal to three times the impedance of the coaxial line.

The effectiveness of arrangements such as that shown in FIG. 1 depends on the frequency band and the dimensions of the coaxial line having regard to the waveguide in use. As the dimension *d* is increased it becomes increasingly difficult, or even impossible, to achieve an impedance match by variation in the dimension *d*.

If the coaxial line has to carry high power, its impedance and its diameter D will be chosen for minimum attenuation compatible with ensuring that substantially no propagation of the T.E. 11 coaxial mode takes place.

These considerations automatically lead to a large value of the dimension *d* which sets a physical limitation on the arrangement.

The present invention has for its principal object the provision of a coupling or transition in which the aforementioned difficulties are reduced and in which the voltage standing wave ratio (VSWR) can be substantially improved.

According to the present invention there is provided an electric wave-transmitting structure comprising a waveguide coupled to a coaxial line projecting laterally therefrom, the dimensions and constitution of the waveguide at its junction with the coaxial line being such as to provide substantially a match between the impedances of the waveguide and coaxial line and the cross-sectional dimensions of the centre conductor of the coaxial line being substantially increased in the region of the said junction.

The waveguide may be of rectangular cross-section and the coaxial line may extend, preferably at right angles, from a broad wall of the waveguide. The portion of centre conductor of increased cross-sectional dimensions may extend from within the outer conductor of the coaxial line across the mouth of the waveguide to a broad wall of the waveguide. This portion of centre conductor is conveniently, but not necessarily, of circular cylindrical shape. It may, however, be of conical or other shape.

A back cavity may be provided in known manner extending from the said junction in a direction opposite to the waveguide.

The coupling according to the invention may be designed to permit rotation of the waveguide about the axis of the centre conductor. The enlarged portion of centre conductor may then be fixed to a broad wall of the waveguide with the normally dimensioned part of the centre conductor passing through and spaced from the enlarged portion, a choke being provided between the ends of the enlarged and normal parts of the centre conductor. Alternatively the enlarged portion of the centre conductor may be fixed to the remainder of the centre conductor and spaced suitably from the adjacent waveguide portion excepting at the extremity of the enlarged portion.

The invention will be described, by way of example, with reference to FIGS. 2 and 3 of the accompanying drawings,

FIG. 2 being a diagrammatic view, similar to that of FIG. 1, of one embodiment of the invention and FIG. 3 being a cross-sectional view of another embodiment of the invention permitting relative rotation between the waveguide and the coaxial line.

Referring to FIG. 2, there is provided at the end of the centre conductor **12** in the junction region an enlarged portion **16**, which is conveniently of cylindrical shape. This portion **16** extends from within the outer conductor of the coaxial line **11** across the mouth of the waveguide **10** and is fixed to a broad wall of the waveguide. Best results have been found empirically to be obtained with values of *b* (the diameter of the portion **16**) such that $d=1.46b$. The dimension L, namely the height of the portion **16** above the broad wall on which it is mounted, largely determines the band width of the transition. The dimension *d* is adjusted for optimum VSWR. The VSWR of the arrangement of FIG. 2 can show an improvement over that of the arrangement of FIG. 1 from approximately 1.6 to 1.13. The short-circuiting face **14** is shown in FIG. 2 as provided by a plunger.

The edge **17** of the portion **16** may be radiused to raise the voltage at which voltage breakdown occurs.

Referring now to FIG. 3, one end of the outer conductor of the coaxial line is fixed at **18** in an aperture in the upper broad wall of the waveguide **10**, a rotatable joint of known kind being provided in the outer conductor to permit its rotation relative to the waveguide **10**. This joint and a choke associated in known manner therewith are not shown in the drawing. The inner conductor **12** passes through and is spaced from an enlarged portion **16'**, corresponding to the portion **16** in FIG. 2. The lower end of the centre conductor is journalled in a bearing **19** in a block **20** fixed to the lower wall of the wave-

guide. The portion **16'** is fixed in an aperture **21** in the top step of the impedance-matching transformer. A choke **22** is provided between the lower end of the centre conductor, and the impedance transformer **23**.

An impedance-matching transformer of about five steps has been found to be the best compromise between the mechanical difficulties likely to be encountered in lengthening the portion of the waveguide containing the steps, i.e. increasing the number of steps, and the VSWR required over the stepped portion and the VSWR at the point of transition.

In a modification of the arrangement of FIG. 2 or FIG. 3, impedance matching is achieved by means of a body of dielectric material instead of the conducting material **23** and the portion **16'** extends through an aperture in this body. The body of dielectric material may have a stepped form, as in the case of the conducting material **23**, or it may be of unstepped wedge shape. When the body is of dielectric material, the centre conductor **12** may be in contact with the wall of the aperture in the wedge-shaped body. In the case of FIG. 3, the portion **16'** may either be fixed to the centre conductor **12** or to the wedge.

The cavity **13** to the right of a plane through the axis of the centre conductor **12**, and perpendicular to the plane of the paper as viewed in FIG. 3, may have a dimension perpendicular to the plane of the paper greater than that of the waveguide.

The impedance-matching transformer, whether stepped or tapering, may have the width of the waveguide or may extend across only a part of the width, in other words it may take the form of a ridged waveguide.

What is claimed is:

1. In an electric wave-transmitting structure comprising a waveguide, and a coaxial line having a center conductor surrounded by an outer conductor, said waveguide having two broad walls and two narrow walls, said outer conductor being connected to one broad wall and said center conductor extending across the waveguide interior and terminating in a portion of enlarged cross-sectional dimensions connected to the other broad wall, the improvement consisting in that the portion of center conductor of increased cross-sectional dimensions is longer than the distance between said broad walls so as to extend from a region within the outer conductor of the coaxial line across said waveguide interior to said other broad wall.

2. A structure according to claim **1**, wherein said centre conductor has a normally dimensioned part adjacent said enlarged portion, said normally dimensioned part and said enlarged portion being fixed together.

3. A structure according to claim **1**, wherein said centre conductor has a normally dimensioned part adjacent said enlarged portion, wherein said enlarged portion of the centre conductor is apertured, and wherein said normally dimensioned part of the centre conductor passes through and is spaced from said aperture in the enlarged portion.

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