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TRANSMISSION SYSTEM

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FIG. 1.

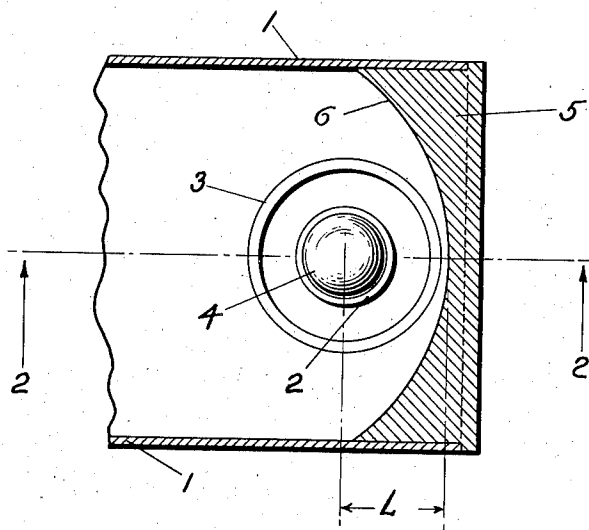
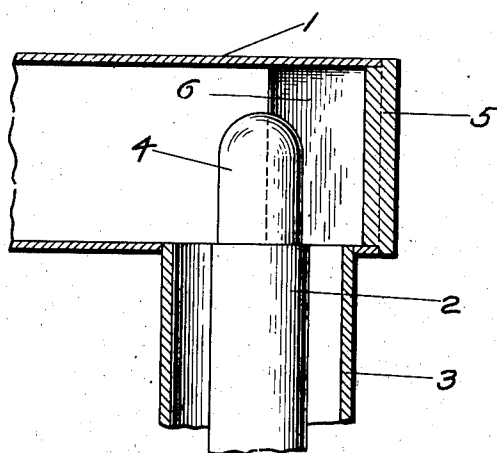


FIG. 2.



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TRANSMISSION SYSTEM

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2 Claims. (Cl. 178-44)

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This invention relates to a guided electromagnetic wave transmission system, and more particularly to a coupling arrangement between a coaxial conductor transmission line and a dielectric wave guide.

In devices of the type to which the invention relates, a suitable terminal device is provided at the junction between the coaxial line and the wave guide for exciting and receiving electromagnetic waves of various types. The terminal may be an extension of the central conductor of the coaxial transmission line projecting from the coaxial line into the hollow wave guide and constituting an exciting rod providing a coupling between the coaxial line and guide.

In such coupling devices a reflecting plate is provided adjacent the exciting means and it is essential that the wave reflected from the reflecting plate at the end of the guide combine in proper phase with the direct wave propagated from the exciting means.

Heretofore it has been the common practice to space a flat reflecting plate a distance approximately equal to one-quarter of the length of the waves on the transmission line from the exciting means. In such an arrangement the portion of the wave guide behind the exciting means constitutes a resonant chamber termination for the wave guide. Such resonant chambers add cumbersome projections on the transmission system which increase the bulk and cost thereof.

It is among the objects of the present invention to provide an arrangement in which the reflecting plate may be spaced closely to the exciting rod thereby avoiding the necessity for such projecting resonant chambers, but without sacrificing any of the desirable electrical characteristics of the system.

It is a further object of the invention to provide a reflecting plate which will introduce far less frequency sensitivity than previous types of reflecting plates which were necessarily spaced further from the junction between the coaxial line and wave guide.

The foregoing and other objects of this invention will be made fully apparent to those skilled in the art from a consideration of the following detailed description taken in conjunction with the accompanying drawing in which:

Fig. 1 represents a section through a coupling between a wave guide and a concentric line having a reflecting plate constructed and arranged in accordance with the present invention; and

Fig. 2 represents a section taken along the line 2-2 of Fig. 1.

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Referring to the drawing, a dielectric wave guide 1, which in this instance is rectangular, is coupled to a coaxial conductor transmission line comprising a central conductor 2 and an outer tubular conductor 3. The members 1, 2 and 3 are of highly conductive material, such as copper or brass. One end of the tubular conductor 3 is joined to the wide side of the wave guide 1 which is provided with an opening therein substantially of the size of tubular conductor 3, through which opening the conductor 2 projects for a substantial distance into the wave guide to provide an exciting rod 4, or equivalent exciting means.

Coaxial conductor transmission lines and dielectric wave guides are usually designed to carry electromagnetic waves of a predetermined wave length in the guide, which may be represented by λ . In many applications it is desired to transmit a range of frequencies corresponding to a wave band extending on either side of λ for one or two per cent. thereof, or in some instances as great as ten per cent.

When electromagnetic waves of sufficiently high frequency are transmitted along the coaxial transmission line, waves are propagated along the length of the wave guide 1 in both directions from the terminal device provided by the projecting end 4 of the central conductor 2. In order that the reflected waves combine in proper phase with the oppositely directed waves, it is the common practice, as pointed out above, to provide an end plug or plate having a flat reflecting surface which surface is spaced a distance approximately equal to $\lambda/4$, or an odd multiple thereof, from the exciting means. I have found that such spacing may be avoided and the electrical characteristics of the system improved by providing the plug 5, which closes one end of the wave guide 1, with a cylindrically concave surface 6 facing the terminal rod 4 to reflect the waves propagated in the undesired direction back in the desired direction along the length of the guide. Preferably the plug is so positioned that a straight line joining the ends of the plug, which project the farthest into the wave guide 1, will pass through or close to the axis of the exciting rod 4. The plug 5, however, should not occlude the opening of the coaxial line into the wave guide. Such occlusion may be avoided by making the distance L between the center line of the exciting rod 4 and the depth of the trough, provided by the curved surface 6, equal to or greater than the radius of the coaxial line. Thus, at the point closest to the coaxial line, the plug 5 does not obstruct the open end of conductor 3.

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The radius of curvature of the surface 6 depends upon the geometry and dimensions of the wave guide 1 and conductor 3, and of course upon the relative position of the exciting means 4. In the instance shown the wave guide 1 is rectangular in transverse section, the exciting rod 4 enters the guide through the wide dimension thereof, and the diameter of the conductor 3 is substantially less than this wide dimension of the guide. Under these conditions the curvature of the surface 6 is substantially greater than the radius of the tubular conductor. For example, in one commercially successful embodiment of the invention where the internal dimension of the wide side of the wave guide was $2\frac{3}{4}$ " and that of the narrow side was $1\frac{1}{4}$ ", the radius of curvature of the surface 6 was $1\frac{3}{4}$ ". In this instance the diameter of the tubular conductor 3 was $1\frac{1}{2}$ ". From the foregoing it will be apparent that in practice the axis of curvature of the cylinder 6 will lie within the guide 1 on the opposite side of the rod 4 from said surface. The axis of curvature will extend parallel to the axis of the rod 4 and will lie in the same longitudinal plane through the guide as the axis of said rod.

The axis of the curvature of the surface 6 is in any case parallel to the axis of the exciting rod 4. Where the diameter of the outer tubular conductor of the transmission line more closely approaches the dimension of the side of the guide, through which the exciting rod 4 projects, the radius of curvature will become less and in the limiting instance approach the radius of the conductor 3. For example, where the coaxial transmission line enters the wave guide through the narrow side thereof, and the exciting means extends parallel to the wide sides of the guide instead of to the narrow sides as shown, it will be apparent that the diameter of the tubular conductor 3 will more closely approach this narrow dimension of the guide and the radius of curvature of the surface 6 will approach the radius of the tubular conductor 3. It will be apparent that under these conditions the axis of curvature of the surface 6 will still be made parallel to the axis of the exciting rod 4.

I have found that when constructed as described in the foregoing, the reflecting surface 6 functions to reflect the waves propagated in the direction of the reflecting surface in phase with the waves propagated in the direction of the length of the guide and without substantial differences in the attenuation of the waves throughout the frequency range of the system. Thus the reflecting plate introduces far less frequency sensitivity than previous types of reflecting plates spaced at such a distance as to provide a resonant chamber between the exciting rod and the reflecting plate.

Although the reflecting surface is actually spaced from the exciting means by a distance sufficient to leave the opening between the coaxial line and wave guide free and unobstructed, the effect of reflecting surface is the same, as far as reflectionless transmission is concerned, as if a flat reflecting surface were placed very close to

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or coincident with the exciting means. The present invention provides an effective reflecting plane very close to or coinciding with the exciting means without the practical difficulties which actual coincidence by a physical surface would introduce. Accordingly, it will be understood that, as used herein and in the appended claims, such expressions as "having an effective reflecting plane substantially coincident with said exciting means" refer to a reflecting member which may not actually so coincide but which has the effect of a theoretically coincident reflecting plane.

There has been herein described a preferred embodiment of the invention. Other embodiments within the scope of the appended claims will be apparent to those skilled in the art from a consideration of the form shown and the teachings hereof.

What is claimed is:

1. A coupling system comprising a coaxial conductor transmission line having an outer cylindrical conductor surrounding an inner conductor, a hollow wave guide, said inner conductor extending into said hollow wave guide through an opening in a wall of said wave guide and forming an exciting rod, said outer conductor being connected to said wall, an electromagnetic wave reflecting plug disposed in said wave guide at one side of said exciting rod, said plug having a cylindrically concave surface adjacent said exciting rod, the axis of curvature of said surface being parallel to the axis of said exciting rod, and the radius of curvature of said surface being constant and at least equal to the internal radius of said outer conductor of said transmission line.

2. A coupling system comprising a coaxial conductor transmission line having an outer cylindrical conductor surrounding an inner conductor, a hollow wave guide, said inner conductor extending into said hollow wave guide through an opening in a wall of said wave guide and forming an exciting rod, said outer conductor being connected to said wall, an electromagnetic wave reflecting plug disposed in said wave guide at one side of said exciting rod, said plug having a cylindrically concave surface adjacent said exciting rod, the axis of curvature of said surface being parallel to the axis of said exciting rod and positioned on the side of said rod remote from said plug, and the radius of curvature of said surface being constant and at least equal to the internal radius of said outer conductor of said transmission line.

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