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SOLID DIELECTRIC WAVEGUIDE WITH METAL PLATING

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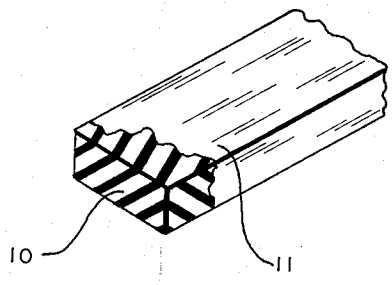


FIG. 1

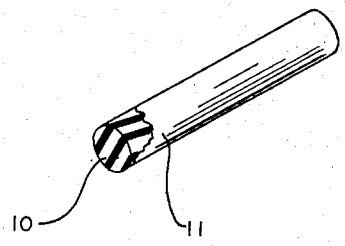


FIG. 2

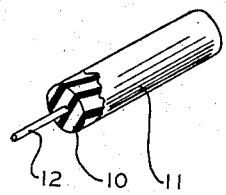


FIG. 2-A

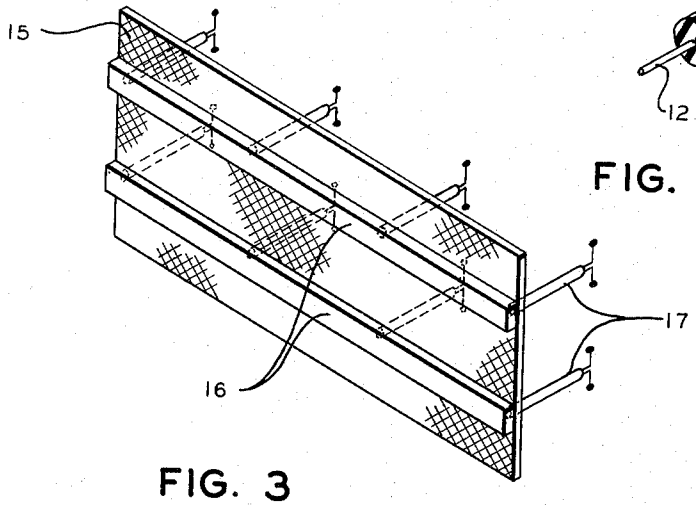


FIG. 3

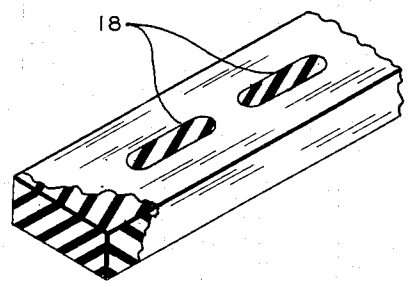


FIG. 4

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SOLID DIELECTRIC WAVEGUIDE WITH METAL PLATING

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3 Claims. (Cl. 343—771)

This invention relates to waveguides, and more particularly to waveguides employing a solid dielectric substance as the propagating medium.

Heretofore, waveguides of the hollow pipe variety have consisted of rugged metallic walls containing air as the propagating medium, but these are bulky, difficult to construct, and are not easily adapted to the problem of feeding properly phased energy to the radiating elements of an antenna array.

An object of the present invention is to provide a small and simply constructed waveguide for carrying electromagnetic waves without serious energy loss.

Another object is to provide a waveguide utilizing a solid dielectric substance as the propagating medium.

Another object is to provide a waveguide which is readily adaptable for use as a slot type radiator.

A still further object is to provide a waveguide whose physical dimensions are not appreciably affected by variations in temperature.

To achieve the above objects, a form of waveguide is constructed which comprises a solid dielectric rod, commonly of rectangular or circular cross-section, which is plated on its outer surface with a good conducting material such as copper or silver.

The invention is fully described in the following specification and the drawings of which:

Fig. 1 is a perspective view of a rectangular waveguide constructed in accordance with the invention;

Fig. 2 is a perspective view of a circular wave guide constructed in accordance with the invention;

Fig. 2A is a perspective view of the waveguide of Fig. 2 adapted to become a coaxial line;

Fig. 3 is a view of an antenna utilizing the waveguide of this invention as a feed;

Fig. 4 is a view of the waveguide of this invention used as a radiator.

Referring specifically to Figs. 1 and 2, the waveguides shown are formed from a solid strip or rod **10** of a low-loss dielectric material such as polystyrene. The outer surface of strip or rod **10** is coated or plated with a good conducting material such as copper or silver to form a covering **11**. This conducting material may be applied by a known process such as electroplating. Electromagnetic energy is propagated through the dielectric rod or strip **10** and is confined therein by the conducting material coated or plated thereon.

By the use of a dielectric propagating medium, the wave length of energy in rectangular waveguide is lessened in accordance with the well known equation

$$\lambda_g = \frac{\lambda_a}{\sqrt{\frac{\epsilon_g}{\epsilon_a} - \left(\frac{\lambda_a}{\lambda_c}\right)^2}}$$

where λ_c is cutoff wave length λ_a and ϵ_a are wave length and dielectric constant in air and λ_g and ϵ_g are wave length and dielectric constant in the guide. As a result,

the required physical dimensions of the guide are lessened, thus providing desired compactness.

It will be obvious to those skilled in the art that the circular wave guide of Fig. 2 may be adapted, as in Fig. 2A, to use as a coaxial line by disposing a conducting rod **12** in the dielectric material **10** along the axis of the outer conducting sheath **11**. The well known coaxial line wave length equation

$$\lambda_g = \frac{\lambda_a}{\sqrt{\frac{\epsilon_g}{\epsilon_a}}}$$

whose symbols are consistent with those defined above, indicates that the wave length of energy in the coaxial line may be diminished as in the above wave guide example by the introduction of a solid dielectric propagating material. Such changes of wave length in coaxial line do not, however, affect the diametrical dimensions of the line which are determined by voltage gradient considerations alone.

The electrical length of a solid dielectric wave guide or coaxial line depends on dielectric constant, and in a number of applications, this type of phase control is advantageous. Fig. 3 illustrates an example of such a situation and shows a linear antenna array having a reflector **15** and dielectric wave guides **16** feeding an array of dipoles **17**. Such array is designed for broadside radiation (i. e. outward in a direction perpendicular to the plane of the reflector) and this requires that all the dipoles be excited in phase but that they be geometrically arranged so that their side radiation is cancelled. By the use of dielectric wave guide **16** or dielectric coaxial line to feed the radiating elements **17**, these conditions are easily achieved and without the necessity of driving alternate dipoles in phase opposition.

Dielectric wave guide is also used to advantage in end-fire antenna arrays wherein it is desired that the wave length of energy in the wave guide feeding the dipoles be the same as that in free space.

Wave guides having radiating apertures such as slots are easily constructed from the guides of Figs. 1 and 2 by either selective plating or by scraping away plating where it is not needed. Such a radiator, having radiating slots **18**, is shown in Fig. 4.

For situations where it is desired to keep the temperature expansions and contractions of a wave guide at a minimum, a low expansion dielectric material is used in the wave guide of this invention. The metallic plating on the dielectric is very thin and its dimensional variations with temperature are thus negligible.

The invention described in the foregoing specification need not be limited to the details shown, which are considered to be illustrative of certain forms the invention may take. What we desire to be secured by Letters Patent and claimed is:

1. The method of fabricating a wave guide component for the transmission of electromagnetic energy which comprises the steps of forming from a low loss solid dielectric material a member having a shape and cross section corresponding to the wave guide component desired, plating the surface of said dielectric member with a metallic coating sufficiently thick to confine electromagnetic energy within said medium without radiation loss and removing predetermined areas of said metallic coating through which electromagnetic energy is to pass.

2. The method of fabricating an antenna for the radiation of electromagnetic energy which includes the steps of forming from a low-loss solid dielectric material a member having the shape and cross section corresponding to that of the antenna desired, electroplating to the outer surface of said member a layer of conductive material

having a thickness sufficient to confine electromagnetic energy within said member without radiation loss yet thin enough to be substantially unaffected dimensionally by normal temperature variations and removing portions of said conducting layer at predetermined locations to permit radiation therethrough, the shape of said portions removed determining the beam characteristics of the antenna.

3. A wave guide member for the propagation of electromagnetic energy comprising a solid, low-loss dielectric member having a shape and cross-section corresponding to that of the waveguide component desired, said member having selected areas of its outer surface coated with a metallic deposit of a thickness sufficient to confine electromagnetic energy within said dielectric member without radiation loss therethrough and of a thinness sufficient to be substantially unaffected dimensionally by normal temperature variations.

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