

United States Patent

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[54] **MICROWAVE ABSORBER FOR WAVEGUIDE**
TERMINATION
6 Claims, 9 Drawing Figs.

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[50] Field of Search **333/22, 81,**
81 B, 98 (M); 338/223—225; 252/62.54

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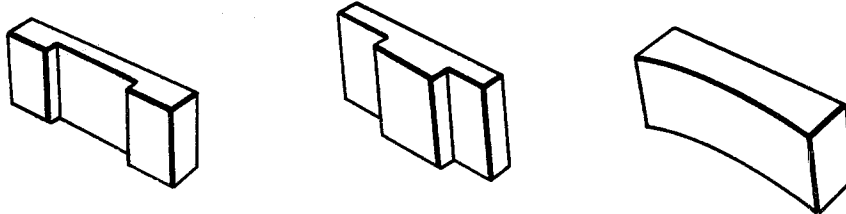
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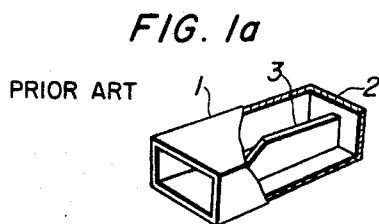
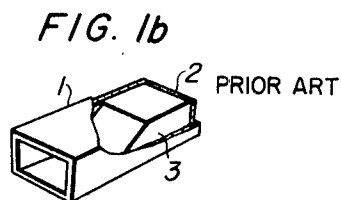
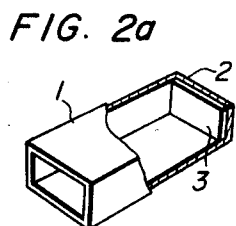
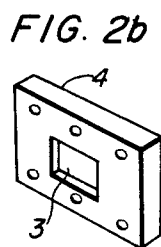
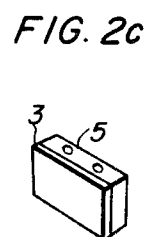
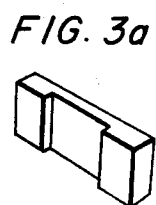
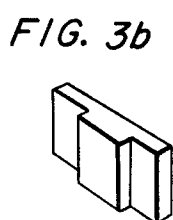
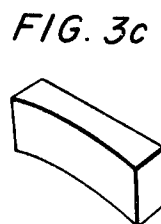
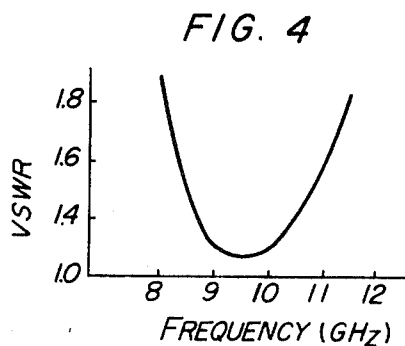
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ABSTRACT: A microwave terminator having a microwave absorber in the form of a plate which is fixed bodily to a short-circuiting plate of metal disposed at a right angle with the axis of a waveguide. The microwave absorber is made from a composition consisting of a powdery ferromagnetic material, carbon powder and a binder therefor, and is shaped to have a stepwise or continuously varied thickness distribution.





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MICROWAVE ABSORBER FOR WAVEGUIDE TERMINATION

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a microwave terminator for use in a waveguide circuit.

2. Description of the Prior Art

Microwave terminators for use in waveguide circuits have hitherto been proposed in various forms. One form of the prior art microwave terminator has a structure as shown in FIG. 1a. In FIG. 1a, a short-circuiting plate 2 of metal material and an absorbing member 3 having a resistive film deposited on the surface of a plate of dielectric material are disposed at the end of a rectangular waveguide 1. As seen in FIG. 1a, the absorbing member 3 is disposed along the centerline of the rectangular waveguide 1 so that it lies in parallel with the electric field of the TE_{10} mode, and the end of the absorbing member 3 remote from the short-circuiting plate 2 is suitably tapered or stepped for the sake of impedance matching.

Another form of the prior art microwave terminator has a structure as shown in FIG. 1b. In FIG. 1b, a short-circuiting plate 2 of metal material and an absorbing member 3 are disposed at the end of a rectangular waveguide 1 as in the case of FIG. 1a. The absorbing member 3 in FIG. 1b has such a shape that its end adjacent to the end of the waveguide 1 extends across the full width of the waveguide 1 and the other end remote from the short-circuiting plate 2 is suitably tapered or stepped for the sake of impedance matching.

In the prior microwave terminator represented by FIGS. 1a and 1b, the absorbing member has such a function that it acts on microwaves to impart attenuation to the electrical energy of the microwaves and therefore its length in the axial direction of the waveguide must be at least equal to the guide wavelength that can be transmitted by the waveguide. Because of such a requirement, these microwave terminators occupy a large space when used as a matching load for various waveguide circuits and thus become a great hindrance in many cases to the reduction in the size and weight of the system. In the worst case, the largeness in size of the microwave terminator gives rise to the undesirable situation that the overall size and weight of the system become excessively great beyond the predetermined values.

SUMMARY OF THE INVENTION

It is therefore a primary object of the present invention to provide a microwave terminator having an extremely reduced axial dimension thereby overcoming the difficulties encountered with prior art microwave terminators.

In accordance with the present invention, there is provided a microwave terminator comprising a short-circuiting plate of metal material disposed at a right angle with the axis of a waveguide, and a microwave absorbing member in the form of a plate fixed to said short-circuiting plate while bodily contacting therewith.

The above and other objects, features and advantages of the present invention will be apparent from the following description of a few embodiments thereof taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1a and 1b are partly cutaway perspective views of prior art microwave terminators.

FIG. 2a is a partly cutaway perspective view of an embodiment of the microwave terminator according to the present invention.

FIGS. 2b and 2c are perspective views of other embodiments of the present invention.

FIGS. 3a, 3b and 3c are perspective views showing various shapes of a microwave absorbing member employed in the terminator according to the present invention.

FIG. 4 is a graph showing the operating characteristic of the microwave terminator according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 2a, an embodiment of the microwave terminator according to the present invention comprises a short-circuiting plate 2 of metal material and a microwave absorbing member 3 in the form of a plate which are disposed at the end of a rectangular waveguide 1. The absorbing member 3 is in bodily intimate contact with and fixed to the short-circuiting plate 2. The absorbing member 3 does not act on the electric field since the electric field on the surface of the short-circuiting plate 2 is zero. However, the absorbing member 3 acts on the magnetic field and wall current to impart a loss thereto.

Another embodiment of the thin microwave terminator according to the present invention shown in FIG. 2b comprises a waveguide flange 4 which has a central recess whose size is equal to the inside dimensions of the section of an associated waveguide. An absorbing member 3 is fitted within the recess and is brought into intimate contact with the end face of the waveguide as in the case of FIG. 2a. The microwave terminator shown in FIG. 2b is adapted for connection with another waveguide flange so as to exhibit an effect entirely similar to that given by the microwave terminator shown in FIG. 2a.

A further embodiment of the thin microwave terminator shown in FIG. 2c comprises a short-circuiting plate 5 of metal material which is so sized as to be equal to the inside dimensions of the section of an associated waveguide or to have a suitable clearance with respect to the inside dimensions of the section of the waveguide. An absorbing member 3 in the form of a plate is in bodily intimate contact with and fixed to the short-circuiting plate 5. The absorbing member 3 is directed toward the transmitting direction of microwaves and is fixed within the waveguide. It will be understood that the microwave terminator thus obtained exhibits an effect similar to that given by the microwave terminator shown in FIG. 2a.

An example of the operating characteristic of these microwave terminators is illustrated in FIG. 4, from which it will be seen that the microwave terminator according to the present invention involves those factors which relate to frequencies. These factors include the composition, method of manufacture and thickness of the absorbing member.

Consider now several absorbing members which have the same composition and are made by the same method, then it will easily be imagined that each individual absorbing member exhibits its best operating characteristic at the thickness which is a function of a specific frequency. On the basis of the above discussion, it can be concluded that the absorbing member may have a thickness distribution including the best thickness t_1 , for a frequency f_1 , best thickness t_2 for a frequency f_2 , etc. For example, absorbing members shown in FIGS. 3a and 3b have a stepwise varied thickness distribution, while an absorbing member shown in FIG. 3c has a continuously varied thickness distribution. It is possible by use of such absorbing members to further improve the operating characteristic of the microwave terminator over a wide frequency range.

The absorbing members shown in FIGS. 2 and 3 are made by binding a mixture of a powdery ferromagnetic material and carbon powder with a synthetic resin binder such as an epoxy resin and baking the composition. The proportion by weight of the ferromagnetic material and carbon in the mixture ranges from 20:80 percent to 80:20 percent, and the proportion by weight of the mixture and the binder ranges from 40:60 percent to 70:30 percent. The ferromagnetic material and carbon have preferably a grain size of 1 to 20 microns.

The composition consisting of the mixture of these powders and the binder is heated to boil being continuously agitated until it solidifies, and the solid thus obtained is pulverized again into particles having a grain size of the order of 20 to 500 microns. The powdered composition is then packed into a mold of a predetermined size and baked for 5 to 15 minutes at a constant temperature between 160° C. and 220° C., the molded body being then slowly cooled to obtain the absorbing member as the product.

The axial length of the microwave terminator made by the method described above can be made very short or less than

one-tenth the guide wavelength for a particular hollow waveguide, and thus the microwave terminator with such a small thickness can effectively be used for the desired reduction in size of the system incorporating it. The microwave terminator is usable in a high-power transmission system by virtue of its good heat dissipation effect because the absorbing member is in intimate contact with the metal end plate.

We claim:

1. A microwave terminator for a waveguide comprising a short-circuiting plate of metal material disposed at a right angle with the axis of the wave guide, and a microwave absorbing member in the form of a plate fixed to said short-circuiting plate while in bodily contact therewith, in which said microwave absorbing member is made by mixing a powdery ferromagnetic material having a grain size of 1 to 20 microns with carbon powder having a grain size of 1 to 20 microns in the proportion by weight of 20:80 percent to 80:20 percent, mixing the mixture with a synthetic resin binder in the proportion by weight of from 40:60 percent to 70:30 percent, heating to boil the composition until it solidifies, pulverizing the composition into powder having a grain size of 20 to 500 microns, and baking the powder for 5 to 15 minutes at a constant temperature between 160° C. and 220° C.

2. A microwave terminator according to claim 1, in which said microwave absorbing member is molded to have a stepwise varied thickness distribution.

3. A microwave terminator according to claim 1, in which said microwave absorbing member is molded to have a continuously varied thickness distribution.

4. A microwave absorbing member in the form of a plate for use in a microwave terminator for a waveguide, characterized in that said microwave absorbing member is fixed while in bodily contact with the short-circuiting plate of metal material disposed at a right angle with the axis of the waveguide, and further characterized in that said microwave absorbing member is made by mixing a powdery ferromagnetic material having a grain size of 1 to 20 microns with carbon powder having a grain size of 1 to 20 microns in the proportion by weight of from 20:80 percent to 80:20 percent, mixing the mixture with a synthetic resin binder in the proportion by weight of from 40:60 percent to 70:30 percent, heating to boil the composition until it solidifies, pulverizing the composition into powder having a grain size of 20 to 500 microns, and baking the powder for 5 to 15 minutes at a constant temperature between 160° C. and 220° C.

5. A microwave absorbing member according to claim 4, characterized in that said microwave absorbing member is molded to have a stepwise varied thickness distribution.

6. A microwave absorbing member according to claim 4, characterized in that said microwave absorbing member is molded to have a continuously varied thickness distribution.

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