Nov. 4, 1947. E. G. LINDER 2,430,130

ATTENUATOR FOR WAVE GUIDES

Filed April 29, 1943

Fig. 1.

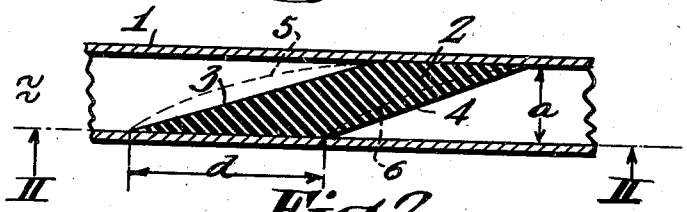


Fig. 2.

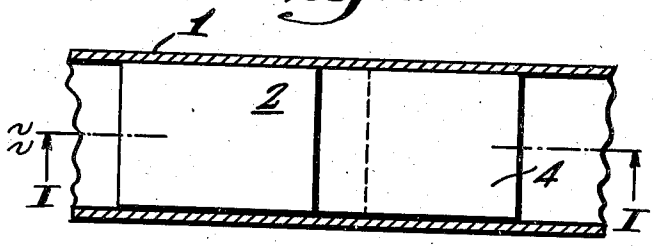


Fig. 3.

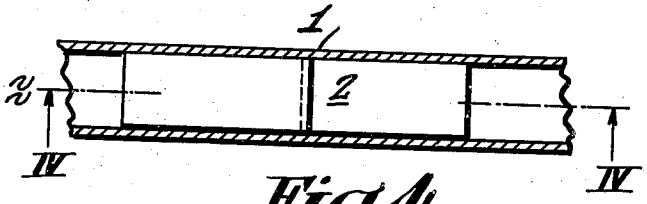
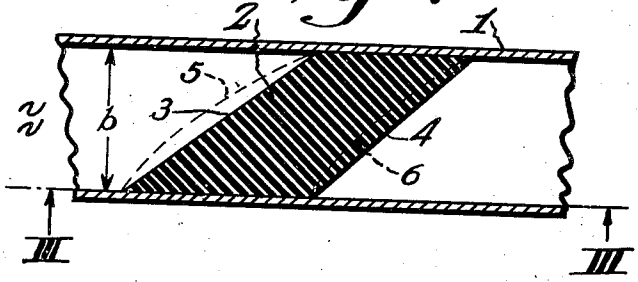


Fig. 4.



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Patented Nov. 4, 1947

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UNITED STATES PATENT OFFICE

2,430,130

ATTENUATOR FOR WAVE GUIDES

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Application April 29, 1943, Serial No. 484,969

6 Claims. (Cl. 178—44)

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This invention relates generally to super-high frequency transmission circuits, and more particularly to an attenuator for super-high frequency wave guides wherein a minimum standing wave ratio may be obtained.

Various attenuating devices have been utilized heretofore in wave guide transmission circuits. Many of these devices have been disadvantageous because of critical frequency characteristics or because of large magnitude wave reflections produced in the wave guide.

The instant invention contemplates the use of graphite impregnated phenolic condensation product, polystyrene-carbon, or similar materials molded and shaped in the form of a plug which is inserted in the wave guide to attenuate super-high frequency energy therein. The plug is tapered at one or both ends to minimize discontinuity in the wave guide while providing substantially constant attenuation to waves propagated throughout the various portions of the guide.

In a preferred modification of the invention, the attenuator comprises tapered, substantially parallel faces which are presented to the propagated waves. The input and output faces of the attenuator are arranged to form angles of less than 90° with the axis of the wave guide. Similarly, the taper may form an angle of less than 90° with either of the cross-sectional axes of the guide. If a relatively long taper with respect to the cross-sectional dimensions of the guide is provided, quite satisfactory matching between the attenuator and the wave guide may be obtained. With wave lengths of the order of 3 centimeters in a guide having cross-sectional dimensions of ½-inch x 1-inch, a standing wave ratio of the order of 1.1 may be obtained with an attenuator taper of the order of 3 inches. Therefore, under these conditions, the attenuator faces, upon which the propagated waves impinge, will form minimum angles of the order of 9.5 or 19.4° with the axis of wave propagation, depending upon the taper orientation with respect to said waveguide, since

(1) $$\mathrm{Sin}^{-1}\frac{.5}{3}=9.5°$$

and

(2) $$\mathrm{Sin}^{-1}\frac{1}{3}=19.4°$$

Among the objects of the invention is to provide an improved attenuator for super-high frequency energy in a wave guide transmission circuit. Another object of the invention is to provide an improved method of and means for attenuating super-high frequency energy in a wave guide. A further object of the invention is to provide an improved attenuator for insertion in a super-high frequency wave guide transmission circuit wherein the attenuating material is shaped in the form of a plug having tapered faces upon which the transmitted waves impinge.

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The invention will be described in further detail by reference to the accompanying drawing, of which Figures 1 and 2 are cross-sectional elevation and plan, respectively, views (taken along the sections I, II) of one embodiment thereof, and Figures 3 and 4 are cross-sectional views (taken along the sections III, IV) of a second embodiment thereof. Similar reference numerals are applied to similar elements throughout the drawing.

Figures 1 and 2 show a wave guide 1, into which super-high frequency energy is introduced from a source not shown. An attenuator 2 is shaped to extend transversely across the vertical dimension a of the wave guide 1, and to extend the distance d along the axis of wave propagation of the guide. The faces 3 and 4 of the attenuator 2, upon which the transmitted waves impinge, are disposed substantially parallel to each other and form an angle of other than 90° with the axis of wave propagation. These faces also form angles of less than 90° with the vertical cross-sectional axis of the guide. It should be understood that the tapered faces of the guide may form different angles with the guide axes. However, if the faces 3 and 4 are disposed parallel, the attenuation of impinging waves will be uniform throughout the cross-sectional area of the guide.

Figs. 3 and 4 show the sections IV—IV and III—III, respectively, of the wave guide 1, wherein the faces 3, 4 of the attenuator 2 form an angle of less than 90° with the axis of wave propagation and a second angle of less than 90° with the horizontal cross-sectional axis b of the guide. It would appear that the two types of tapers (wherein the attenuator faces form angles of less than 90° with either (1) the vertical axis a or (2) the horizontal axis b), as disclosed, provide equally satisfactory results. The reflections in the wave guide which are caused by the attenuator will be dependent upon the relative lengths of the tapered portions of the attenuator with respect to the cross-sectional dimensions of the guide. If desired, one or both of the tapered faces may be other than plane surfaces, as shown by the dash lines 5, 6. A

curvature of the faces appears to provide less reflection of wave energy than a tapered plane surface. However, in some instances, with curved surfaces, the attenuator may not be made to have an effectively constant thickness along the axis of wave propagation.

Thus the invention described comprises two modifications of an attenuator for super-high frequency energy in a wave guide, wherein the standing wave ratio may be maintained at a relatively low value by tapering the faces of the attenuator incident to the axis of wave propagation in the guide.

I claim as my invention:

1. A dielectric guide attenuator for super-high frequency energy comprising a plug of energy absorptive material disposed within said guide substantially entirely displacing the normal dielectric thereof transversely and for a predetermined distance in the direction of wave propagation of said guide, the transverse faces of said plug being substantially parallel disposed entirely within said guide at other than right angles to said direction of wave propagation.

2. A dielectric guide attenuator for super-high frequency energy comprising a plug of energy absorptive material disposed within said guide substantially entirely displacing the normal dielectric thereof transversely and for a predetermined distance in the direction of wave propagation of said guide, at least one of the transverse faces of said plug being a curved surface having relatively large radii and being disposed within said guide transversely to said direction of wave propagation.

3. A dielectric guide attenuator for super-high frequency energy including a plug of energy absorptive material disposed within said guide substantially entirely displacing the normal dielectric thereof transversely and for a predetermined distance along the axis of wave propagation of said guide, said plug having substantially uniform thickness in all planes parallel to said axis of wave propagation and the transverse faces of said plug being substantially parallel disposed within said guide at a minimum angle of less than 45 degrees to said axis of wave propagation.

4. A dielectric guide attenuator for super-high frequency energy including a plug of energy absorptive material disposed within said guide substantially entirely displacing the normal dielectric thereof transversely and for a predetermined distance in the direction of wave propagation of said guide, said plug having substantially uniform thickness in said direction of wave propagation and the transverse faces of said plug being substantially parallel disposed entirely within said guide at other than a righ angle to said direction of wave propagation.

5. A dielectric guide attenuator for super-high frequency energy including a plug of energy absorptive material comprising a predetermined proportion of graphite and phenolic condensation product disposed within said guide substantially entirely displacing the normal dielectric thereof transversely and for a predetermined distance in the direction of wave propagation of said guide, said plug having substantially uniform thickness in said direction of wave propagation and the transverse faces of said plug being substantially parallel disposed within said guide at other than a right angle to said direction of wave propagation.

6. A dielectric guide attenuator for super-high frequency energy including a plug of energy absorptive material comprising predetermined proportions of polystyrene and carbon disposed within said guide substantially entirely displacing the normal dielectric thereof transversely and for a predetermined distance in the direction of wave propagation of said guide, said plug having substantially uniform thickness in said direction of wave propagation and the transverse faces of said plug being substantially parallel disposed within said guide at other than a right angle to said direction of wave propagation.

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