May 30, 1950 G. L. FERNSLER 2,510,016

APPLICATION OF HIGH LOSS DIELECTRICS
TO WAVE GUIDE TRANSMISSION SYSTEMS
Original Filed April 29, 1943

Fig. 1.

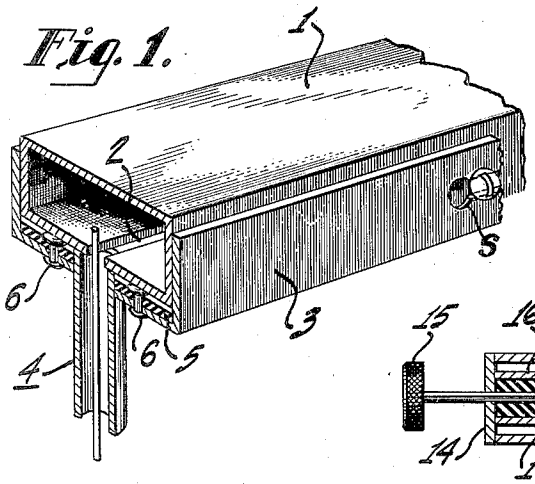


Fig. 2.

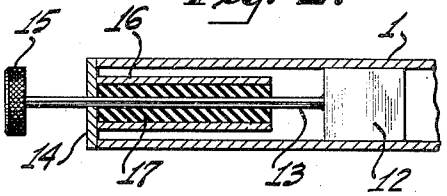


Fig. 3.

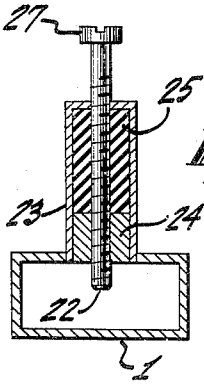
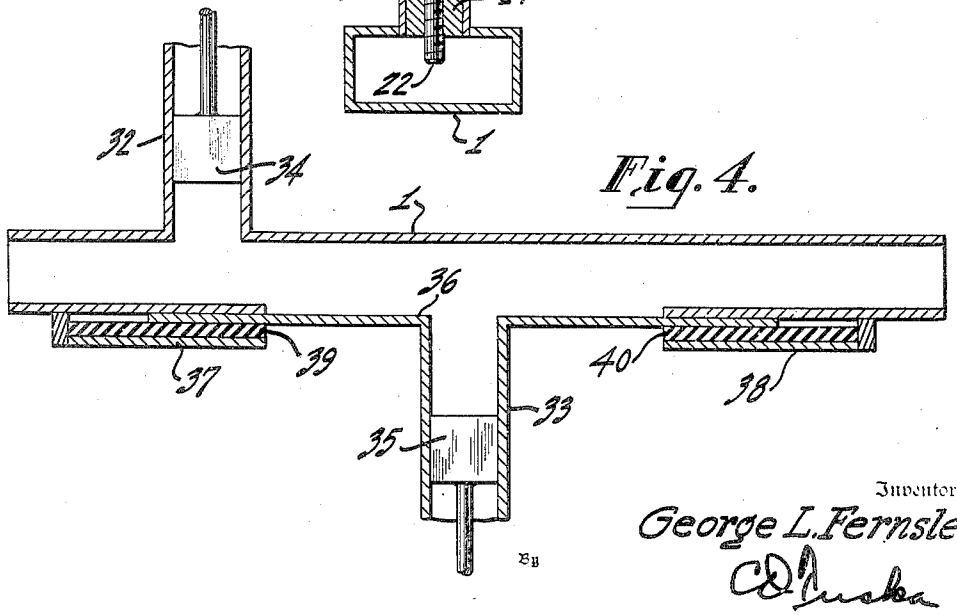


Fig. 4.



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APPLICATION OF HIGH LOSS DIELECTRICS TO WAVE GUIDE TRANSMISSION SYSTEMS

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4 Claims. (Cl. 178—44)

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This application is a division of my copending U. S. application Serial No. 485,012, filed April 29, 1943, now Patent No. 2,465,719, granted March 29, 1949, and assigned to the same assignee as the instant application.

This invention relates generally to super-high frequency apparatus and more particularly to an improved method of and means for preventing leakage of super-high frequency energy between relatively movable conductive elements of a wave guide transmission system.

The instant invention includes improvements upon the apparatus disclosed in the copending U. S. application of Ernest G. Linder, Serial No. 485,357, filed May 1, 1943, now Patent No. 2,443,-109, granted June 8, 1948, in which is described the use of conductive rubber having relatively low resistivity for attenuating super-high frequency energy.

Among the objects of the invention are to provide an improved method of and means for attenuating super-high frequency energy in a wave guide transmission system. Another object of the invention is to provide an improved method of and means for preventing leakage of super-high frequency energy between relatively movable conductive elements of a wave guide system. A further object of the invention is to provide an improved method of and means for preventing leakage of super-high frequency energy along an adjusting device for a matching stub incorporated in a wave guide transmission system.

An additional object of the invention is to provide an improved method of and means for minimizing leakage of super-high frequency energy along external adjusting means for a shorting plug within a super-high frequency wave guide transmission system. Another object is to provide an improved structure for moving relatively two matching stubs along the axis of wave propagation in a super-high frequency wave guide transmission system wherein leakage of super-high frequency energy is minimized by energy-absorptive material secured to the wave guide adjacent the relatively movable conductive elements thereof.

The invention will be described in further detail by reference to the accompanying drawing of which Figure 1 is a cross-sectional perspective view of one embodiment thereof, and Figures 2, 3, and 4 are cross-sectional views of modifications of a second embodiment thereof. Similar reference numerals are applied to similar elements throughout the drawing.

Figure 1 shows a wave guide 1 which includes

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a longitudinal slot 2 extending along a predetermined length of one face of the wave guide 1. A U-shaped bracket 3 of conductive material is shaped to conform to the outside dimensions of the wave guide 1 and arranged to slide longitudinally thereof. The bracket 3 includes slotted holes S, which may be employed for clamping the bracket at any predetermined position longitudinally of the wave guide 1. The bracket 3 is apertured to receive a concentric transmission line 4 which may be disposed at any desired angle with respect thereto. The outer conductor of the transmission line 4 should be soldered, or otherwise electrically connected, to the bracket 3 while the inner conductor of the concentric line extends through the aperture in the bracket 3 and also through the slot 2 of the wave guide 1. It will be seen that the inner conductor of the concentric transmission line 4 will therefore provide a wave probe for pickup of super-high frequency energy within the wave guide and that this probe may be moved longitudinally along the wave guide by shifting the U-shaped bracket 3.

A flat layer of super-high frequency energy-absorptive material 5 such as, for example, conductive rubber having relatively low resistivity, is secured to the inside surface of the central portion of the U-shaped bracket 3 by means of oval-headed rivets 6. The rivets 6 should preferably be irregularly spaced, and well separated from the concentric line 4. The conductive rubber layer 5 will therefore occupy most of the space between the central portion of the U-shaped bracket 3 and the slotted face of the wave guide 1. The rubber layer should be apertured to accommodate the inner conductor of the concentric transmission line 4. The rubber layer 5 will attenuate substantially all leakage energy between the wave guide and the U-shaped bracket 3 while the rivets 6 will provide electrical contact between the bracket and wave guide. Since the conductive rubber layer has relatively low resistivity, the effects of erratic contact between the movable metal parts will be minimized and will provide less interference in the concentric line output circuit, since the field near the rivets which slide on the wave guide 1 is relatively weak due to the high conductive currents through the rubber layer. A conductive rubber layer having a resistivity of 5 ohm-centimeters appears to be entirely satisfactory, and to prevent substantially all erratic contact effects as the probe is moved longitudinally along the wave guide. It will be seen that

applicant's improved structure substantially eliminates two of the most troublesome features of movable elements in super-high frequency wave guide transmission systems, since energy leakages and erratic contact between movable parts normally seriously affect the accuracy of measurements in such systems. The transmission line 4 may be connected to a crystal detector or other utilization apparatus, not shown.

Figure 2 includes a wave guide 1, having a shorting plug 12, which is movable longitudinally along the wave guide 1. Adjustment of the shorting plug 12 may be accomplished externally by means of a shaft 13 which extends through a central aperture in a conductive wave guide terminating plate 14. A knob 15, may be fastened to the external end of the adjusting shaft 13. To prevent leakage of super-high frequency energy past the shorting plug 12, and around the adjusting shaft 13 in the vicinity of the apertured terminating plate 14, a super-high frequency attenuator is provided which effectively prevents energy leakage without affecting the operation of the shorting plug.

The attenuator includes a cylindrical conductive member 16 which is concentric with the adjusting shaft 13 within the wave guide 1. One end of the cylindrical conductive member 16 is terminated in the wave guide terminating plate 14. A conductive rubber dielectric 17 occupies the space between the adjusting shaft 13 and the concentric conductive element 16. The adjusting shaft 13, concentric conductive element 16, and high-loss dielectric 17 therefore comprise a coaxial transmission line of very high impedance which effectively prevents leakage of energy outside of the wave guide. Moreover, the rubber dielectric will provide a satisfactory bearing surface for adjustment of the adjusting shaft 13 for moving the shorting plug 12 longitudinally of the guide.

Figure 3 includes a wave guide 1 apertured to receive a matching stub 22 which is threaded to cooperate with a supporting member 23 disposed normal to the wave guide 1. The matching stub 22 is proportioned to provide a sliding fit with a conductive plug 24 which effectively seals the end of the supporting member 23 adjacent the wave guide 1. In order to prevent leakage of super-high frequency energy past the joint between the conductive plug 24, the tuning stub 22 and the supporting member 23, the remaining space within the supporting structure 23 is filled with conductive rubber 25. Therefore, the supporting structure 23, the tuning stub 22 and the conductive rubber layer 25 provide an extremely high impedance concentric transmission line which effectively prevents leakage of super-high frequency energy along the threaded tuning stub 22. The length of the portion of the tuning stub 22, which extends into the wave guide 1, may be adjusted by turning an adjusting screw head 27 attached to the exterior end of the tuning stub 22.

Figure 4 includes a wave guide 1 having two angularly disposed stub matching sections 32, 33 which include shorting plugs 34, 35, respectively. The shorting plugs may be of the type described in Figure 2 and leakage of super-high frequency energy past the shorting plugs may be prevented in the manner described therein. Matching of a wave guide to a series of complex load circuits may be greatly facilitated by adjusting the relative spacing of the two guide matching stubs. This may be accomplished readily by providing a

telescoping portion 36 of one of the wave guide faces whereby the stud 33 may be moved longitudinally of the guide 1.

In order to prevent leakage of super-high frequency energy between the telescopic conductive face of the wave guide 1 and the movable guide face 36, the guide 1 includes a pair of cover brackets 37, 38 to the inner surfaces of which are secured layers of conductive rubber 39, 40, respectively. Since the cover bracket 37, the conductive rubber layer 39, the movable guide section 36 and the wave guide 1 are all in contact, leakage of super-high frequency energy through the telescopic joint will be attenuated effectively due to the resultant high impedance energy path. The arrangement of the cover bracket 38, the conductive rubber layer 40, the movable guide section 36 and guide 1 is similar to that just described. Therefore, the movable guide section 36 and tuning stub wave guide 33 may be moved in either direction longitudinally along the wave guide 1 to provide predetermined spacing of the guide tuning stubs 32, 33 without involving appreciable leakage of super-high frequency energy through the sliding joints of the wave guide.

Thus the invention described comprises several embodiments and modifications thereof for preventing leakage of super-high frequency energy between relatively movable conductive elements in a wave guide transmission system.

I claim as my invention:

1. A super-high-frequency wave guide structure having an aperture in one portion thereof to receive at least a portion of an externally adjustable impedance element including a device for reducing leakage of super-high frequency energy from between said element and said structure comprising a conductive rubber packing interposed between said adjustable element and said structure, said packing being subjected to sufficient pressure between said movable element and structure to provide substantially uniform contact therewith without deleteriously limiting the movability of said element with respect to said structure.

2. In a super-high frequency wave guide having a slot in one face thereof to receive a super-high frequency probe, a movable element including an apertured conductive element longitudinally movable upon and in electrical contact with said guide, a concentric line section supported by said conductive element, the central conductor of said line section including a probe extending into said guide through said aperture and said slot, and a conductive rubber element interposed between said guide and said conductive element and fastened to said conductive element for reducing leakage of super-high frequency energy between said guide and said conductive element.

3. In a super-high frequency wave guide having an aperture in one face thereof to receive an externally adjustable tuning stub, a device for reducing leakage of super-high frequency energy from said tuning stub comprising a cylindrical conductive element concentric with a portion of said stub externally of said guide, and conductive rubber forming a partially conductive dielectric extending substantially between said cylindrical element and said portion of said stub.

4. In a super-high frequency wave guide structure including an externally adjustable, axially movable conductive shorting plug, a device for reducing leakage of super-high frequency energy around said shorting plug comprising an apertured conductive element closing the end of said

guide structure with the externally adjustable portion of said plug extending through said aperture, a cylindraceous conductive element within said guide connected to said apertured element and concentric with said portion of said plug extending to and through said aperture, and a conductive rubber dielectric interposed substantially between said concentric elements to provide thereby a concentric line attenuator for said leakage energy.

GEORGE L. FERNSLER.

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