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FLEXIBLE WAVE GUIDE TYPE TRANSMISSION LINE

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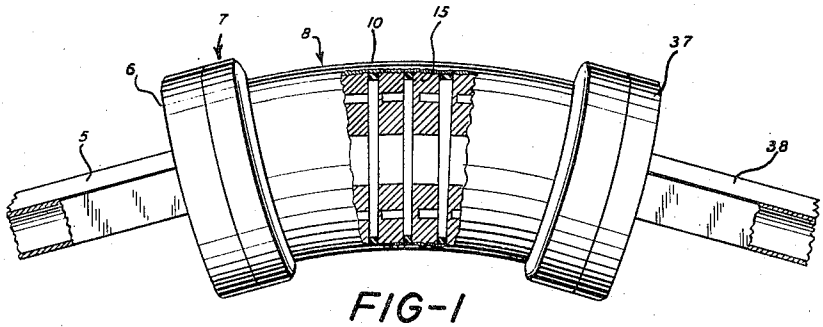


FIG-1

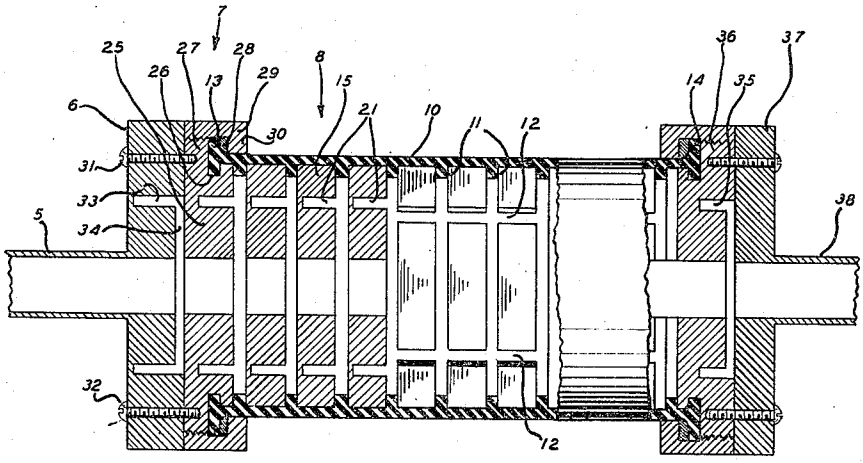


FIG-2

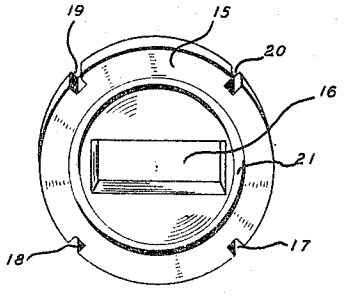


FIG-3

INVENTOR.
JOSEPH E COYLE
ELMER L YOUNKER
BY William D Hall
Attorney

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FLEXIBLE WAVE GUIDE TYPE TRANSMISSION LINE

Joseph E. Coyle, Arlington, and Elmer L. Younker, Cambridge, Mass., assignors, by mesne assignments, to the United States of America as represented by the Secretary of War

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2 Claims. (Cl. 178—44)

1

This invention relates to a transmission line and more particularly to a wave guide type transmission line having considerable flexibility. A line of this flexible character will find many useful applications, such, for example, as a connection between shock-mounted and non-shock-mounted components of an electrical system, or as a feed line for a sector scan type antenna. The present line may be bent to a fixed position; it may be variably bent, as in a "wobble" type joint; or it may be twisted axially, all within a wide range, without introducing substantial transmission losses.

Previous attempts to provide a flexible wave guide have more or less failed to meet reasonable requirements as far as power losses are concerned. Such prior devices have been unable to maintain a tolerably low standing wave ratio, as well as prevent substantial losses due to radiation. The principal object of the present invention, therefore, is to provide a flexible length of wave guide type transmission line wherein losses will be maintained at a satisfactorily low level. The flexible length may be adapted for use in conjunction with the usual non-flexible rectangular or circular wave guide.

The invention relies upon the fact that microwave energy may be transmitted from one section of wave guide to another across a short open space between sections without substantial loss, providing some means are used at the spaced section ends to prevent radiation. Such a means in the present invention takes the form of a quarter wave annular cavity associated with the space between the wave guide sections so as to act as a high frequency choke. Within limits, the distance between sections may be varied without changing the effectiveness of such a choke. The invention, therefore, comprises a substantial number of relatively short wave guide sections mounted in a flexible rubber tube in spaced relation to each other. Each section is in the form of a metallic disc having a central opening therein corresponding to the dimensions of the desired rectangular or circular wave guide. An annular channel, constituting the above mentioned choke, is provided in one face of each wave guide section. As will be understood, bending of such a structure causes merely an inconsequential change in the spacing between individual sections. Any desired number of sections may be used, the number depending generally upon the degree of bend contemplated. Thus, a 60° bend would require roughly twice as many sections as a 30° bend. As one example, a length comprising ten sections and easily providing a 30° bend has been found generally satisfactory for a wide variety of uses.

In the drawing, Fig. 1 is a partly cut away perspective view of a flexible length showing a bend of approximately 30°; Fig. 2 is an elevational view

2

partly in section showing the structural details of said embodiment of the invention; and Fig. 3 is a perspective view of one of the individual wave guide sections.

Referring now to Figs. 1 and 2, a conventional rectangular type metallic wave guide 5 has a coupling flange 6 associated with cooperating coupling structure 7 of a flexible length generally designated by 8. It is, of course, understood that a circular type wave guide could be used if desired. Flexible length 8 includes a preformed flexible rubber tube or housing 10, best shown in Fig. 2. Housing 10 may be fabricated by applying a thin layer of liquid latex to an appropriate Bakelite form, the form having grooves therein for providing certain positioning ribs on the housing interior. Inwardly extending annular ribs 11 are provided at spaced intervals on the interior surface of housing 10. Ribs 11 are of proper width, as hereinafter described, to provide the desired spacing between the individual wave guide sections of the flexible length. Spaced longitudinal ribs 12 are also provided, the purpose of ribs 12 being to insure proper circular alignment (polarization) of the respective sections. Integral outwardly extending annular flanges 13 and 14 are provided at the ends of housing 10 for association with the respective coupling structures of the flexible length.

A metallic wave guide section 15 is best shown in Fig. 3. Section 15 preferably takes the form of a relatively thin metallic disc provided with a rectangular (or circular) central aperture 16 corresponding in size to the wave guide dimensions used. Any suitable conducting metal may be used for section 15, aluminum having been found especially satisfactory as compared to certain other substances which have a harmful effect in time on rubber housing 10. Longitudinally disposed channels 17, 18, 19, and 20 are provided at spaced intervals about the periphery of section 15 to receive the above mentioned aligning ribs 12 of the housing. It will be understood that the cooperating ribs 12 and peripheral channels 17, 18, 19, 20 will maintain sections 15 so that the rectangular central apertures 16 are in substantial register. An annular channel 21 is formed in one face of section 15 around central aperture 16, this face being designated as the front face. In general, the inner diameter of channel 21 is just sufficient to exceed the diagonal dimension of opening 16, as shown in the drawing. The radial width and axial depth of channel 21 must be of the proper dimensions to provide the desired choke action. Such a channel is known as a quarter wave choke, although in practice the depth of the cavity generally is somewhat less than a quarter wave length. Proper dimensions for such a choke cavity are well known in the art. The axial thickness of metallic section 15 is somewhat less than a quar-

ter wave length of the guided wave, the axial distance from one face of a section to the corresponding face of an adjacent section being generally a quarter wave. Thus some latitude is permitted in the axial dimensions of section 15 and spacing ribs 11, it being necessary only that the sum of the two be substantially equal to the said fixed value. The diameter of section 15 is preferably such that a quarter wave electrical distance is provided between channel 21 and the periphery of section 15. The physical distance will be somewhat less than a quarter wave because of the presence of dielectric rib 11.

As seen in Figs. 1 and 2, flexible length 8 comprises a plurality of sections 15 mounted in housing 10 between successive ribs 11, the ribs 11 and 12 cooperating to maintain the sections in proper spaced and aligned position. As will be understood, channel 21 and the front face of one section 15 cooperate with the spaced rear face of the adjacent section to provide the desired choke action and thus avoid losses due to radiation.

Referring to the left-hand end of length 8, terminal wave guide section 25 has a circumferential annular channel 26 to receive the end internal rib of housing 10. Section 25 also has an exteriorly threaded, outwardly extending, annular flange 27 at one end. Flange 27 constitutes a bearing shoulder for rubber flange 13 of housing 10, a ring 28 being provided to clamp flange 13 against said shoulder. A ring nut 29 having an inwardly extending annular flange 30 for cooperation with ring 28 detachably engages threaded section 25 to retain ring 28 against rubber flange 13, thus to securely grip the end of housing 10 in coupling structure 7.

Coupling flange 6 of conventional wave guide 5 is detachably secured to terminal section 25 by means of screws 31 and 32. An annular quarter wave channel 33 is provided in flange 6 in substantial alignment with the channels of the several sections 15, the front face of flange 6 centrally of channel 33 being undercut as shown in Fig. 2 to provide space 34 between said face and the rear face of terminal section 25. Thus channel 33 communicates with the space enclosed by the wave guide through space 34.

Substantially similar coupling structure is provided at the opposite end of length 8. It will be noted, however, that a quarter wave channel 35 provided in terminal section 36 is effectively located at the junction of section 36 and a coupling flange 37 of associated conventional wave guide 38. Therefore, coupling flange 37 does not require an annular channel.

As will be understood, the various dimensions of the above described structure are subject to variation in accordance with transmitted frequency. A more complete understanding of the invention will be possible by reference to the following example wherein detailed dimensions are set forth for a flexible wave guide adapted for use at 1.25 centimeter wave lengths. It is to be understood that the values given are merely exemplary and that they may be subject to variation even for use at this frequency. In this instance, the rectangular wave guide dimensions are .420 and .170 inch. The inner and outer diameters of annular channels 21 (the quarter wave choke) are .490 and .550 inch, respectively, and the channel depth is .112 inch. The axial thickness of section 15 is .122 inch and the spacing between adjacent sections, as determined by the width of ribs 11, is .035 inch. As previously mentioned, the sum of these two dimensions (distance between rear face of one section 15 and the rear face of an adjacent section 15) corresponds generally to a quarter wave length of the guided wave. The outside diameter of section 15 is .740 inch, and the radial length of rib 11 is .041 inch, whereby the electrical distance between channel 21 and the periphery of section 15 (comprising the length of free space and the length of dielectric rib 11) is a quarter wave length. It has been found that a flexible length made up of ten sections dimensioned in accordance with the above example has an insertion loss of less than .1 db. when applied to a conventional non-flexible line. A length of that size will permit bending up to an angle of somewhat in excess of 30° with a power loss of not more than .5 db. at the maximum angle. The voltage standing wave ratio remains constant over the range of bending from 0°–30°, the ratio having a value of 1.04. The length also may be twisted, stretched and subjected to shearing action without incurring substantial losses.

Having thus described the invention, what we claim as new and desire to secure by Letters Patent is:

1. A flexible wave guide type transmission line comprising a plurality of metallic discs, a flexible housing comprising a flexible rubber tube, and integral annular spacing ribs and aligning ribs on the interior surface of said tube, said discs being mounted in said tube between said spacing ribs and having spaced peripheral channels to receive said aligning ribs, each disc having an aperture therethrough constituting a wave guide section and having an annular channel in its front face symmetrically around said wave guide section, said channel being proportioned and disposed so as to cooperate with its associated face and the rear face of the adjacent disc to function as a choke to prevent radiation between said spaced discs, the space between said discs having an electrical distance between said annular channel and the periphery of said discs substantially equal to a quarter wavelength at the frequency of the energy in the wave guide.

2. The combination of claim 1 wherein the axial distance between one disc face and the corresponding face of an adjacent disc is substantially equal to a quarter wave length at the frequency of the energy in the wave guide.

JOSEPH E. COYLE.
ELMER L. YOUNKER.

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