LOW PASS FILTERS

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1 Claim. (Cl. 333—73)

This invention relates to low pass filters for high frequency transmission lines where it is desirable to transmit the lowest frequencies and suppress oscillations at higher frequencies.

Such a filter is useful, for example, in a radar system between the T-R cavity and the mixer. In such a system, higher frequencies than the fundamental frequency generated by an oscillator, such as a magnetron, may pass through the T-R cavity and appear at the mixer where they are not desired. It is not sufficient to reflect the higher frequencies. They must be dissipated, preferably in a resistive load. If they are reflected, resonance may be set up between the cavity and the filter, or between the filter and the mixer at the higher frequencies, with the result that the mixer crystal may be burned out, due to excessive power. Such a filter is needed where it is desired to attenuate all frequencies above a selected frequency.

By the present invention, these results are accomplished in a filter that passes only the lower frequencies and attenuates reactively and resistively the higher frequencies. Such a filter is made of a section of wave guide with a coaxial input and output. The wave guide has a cut-off wave length for the lowest (TE\textsubscript{01}) mode shorter than the longest wave to be passed but longer than the longest undesired wave length. A matching disk is positioned in the wave guide and connected to the coaxial input and output. The desired lower frequencies are not propagated down the wave guide section while all the highest undesired wave lengths are so propagated and are dissipated in the loads terminating the wave guide section. Such a filter passes the lower desired frequencies down the output coaxial cable without substantial loss while tending to suppress all the higher undesired wave lengths both by reflection and absorption.

Other and further advantages of this invention will be apparent as the description thereof progresses, reference being had to the accompanying drawings, wherein:

Fig. 1 is an isometric view partly broken away of a preferred embodiment of the invention; and

Fig. 2 is a transverse section taken along the line 2—2 of Fig. 1.

The numeral 10 indicates a coaxial cable carrying the input signal. This coaxial cable has a central conductor 11 and an outer conductor 12. The coaxial cable 10 is coupled to a section of rectangular wave guide 13 in any convenient manner. The coupling shown is intended to be diagrammatic and any of the well-known forms of such coupling may be used. The central conductor 11 of the cable 10 projects perpendicularly into the wave guide section in the center of the top surface 14 of the wave guide section 13, and is attached to a matching disk 15 which is made of metal and matches the power at the desired frequency from the input to the output through an output coaxial cable 16 introduced at the center of the bottom surface 17 of the wave guide section 13. The central conductor 18 of the cable 16 projects into the center of the wave guide section 13 and is likewise connected to the matching disk 15. It is known that the characteristic impedance of a coaxial cable is determined by the ratio of the diameters of the inner and outer conductors. The matching disk 15 serves to increase the diameter of the inner conductor 11 when the outer conductor 12 increases effectively the width (y) of the wave guide 13 to maintain the ratio of the inner and outer conductors of the cable 10, and hence the characteristic impedance of this cable remains more or less constant when it enters the wave guide 13. The disk 15 provides a match for the desired lower frequencies and also a good reflector for the undesired higher frequencies.

Two loading cards 20 and 21 are inserted with their major axes along the central vertical plane of the wave guide, one at each end 22 and 23 of the wave guide section 13. These loading cards are formed of strips of resistive material, or of dielectric material coated with a conductive material. They may have either the single taper, as shown in Fig. 1, or a double taper to avoid presenting too abrupt a discontinuity to the fields within the wave guide, as such discontinuities will result in the reflection of energy and a high voltage standing wave ratio. The plane of these loading strips 20 and 21 is in the direction of the electrical field in the wave guide section 13. If the energy is propagated down the guide 13 in the TE\textsubscript{m} mode, the cards positioned, as shown, will intercept a portion of the electrical field represented by the arrows 24 in Fig. 2.

In operation, the desired lower frequencies are propagated down the cable 10 in the principal TEM mode into the wave guide section 13, together with certain undesired higher frequencies. These higher frequencies upon reaching the wave guide are propagated along the guide toward its ends 22 and 23 with the electrical field in the direction shown by the arrows 24 in Fig. 2. However, the desired lower frequencies are not propagated down the wave guide because propagation in the wave guide in the TEM mode is limited to energy of a wave length not exceeding twice the width (y) of the guide. The wave guide dimensions are selected so that the cut-off wave length is less than the wave length of the highest desired frequency, and greater than the wave length of the lowest undesired frequency. In the case of the low pass filter, twice the width of the wave guide would be made less than the length of the longest wave to be passed and wider than the length of the shortest wave to be attenuated.

When the undesired energy reaches the loading cards 20 and 21, it is absorbed and dissipated as heat. However, the energy at the desired frequency continues on to the center conductor 18 of the cable 16 and is propagated down the output cable 16 with a minimum of the higher undesired frequencies and with very little loss in energy of the desired lower frequencies.

Other forms of matching and loading devices for use with the invention will occur to those skilled in the art. Several filters incorporating the invention may be used in cascade if needed. In cascading the filter, the dimensions are not very critical, as the effect is resistive rather than reactive. This filter may be used in cascade with others which provide a sharper cut-off but not so wide a range of attenuation. It is especially valuable for cases in which the generator and load are badly mismatched.

This invention is not limited to the particular details of construction, materials and processes described, as many equivalents will suggest themselves to those skilled in the art. It is accordingly desired that the appended claim be given a broad interpretation commensurate with the scope of the invention within the art.
What is claimed is:
In a low pass filter, means for propagating oscillatory energy of a first frequency and energy of at least one higher frequency, said means comprising a coaxial transmission line having a central conductor, auxiliary means arranged with its axis perpendicular to that of the coaxial line for propagating energy at said higher frequency but incapable of propagating energy at said first frequency coupled to said coaxial line, said auxiliary propagating means comprising a section of wave guide having a cross section with dimensions such as to make the cutoff wave length of the guide less than the wave length of the first frequency but greater than the wave length of the lowest higher frequency, absorbing means in the auxiliary propagating means for absorbing energy at the higher frequency, output coaxial transmission line and a disc-shaped matching means of conducting material connecting the central conductors of the input and output coaxial lines and adapted to match the impedance of the coaxial lines to that of the auxiliary transmission line at the higher frequencies and that of the input and output coaxial lines at the lower frequency.

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