Sept. 11, 1956 J. REED 2,762,986

LOW PASS FILTERS

Filed Aug. 24, 1951

FIG. 1

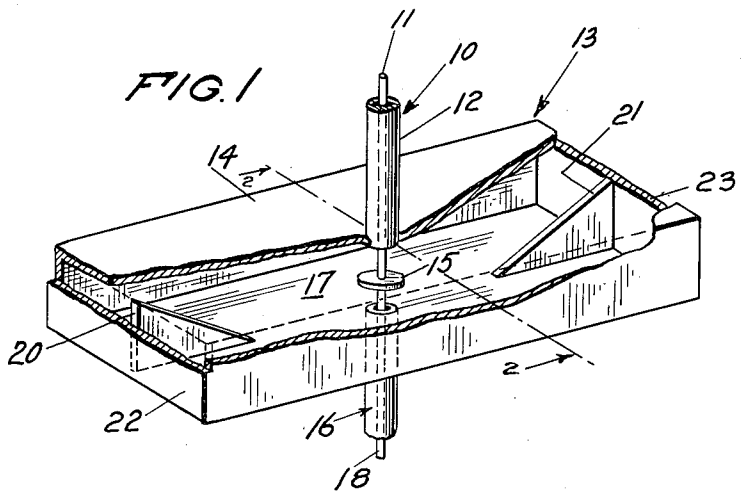
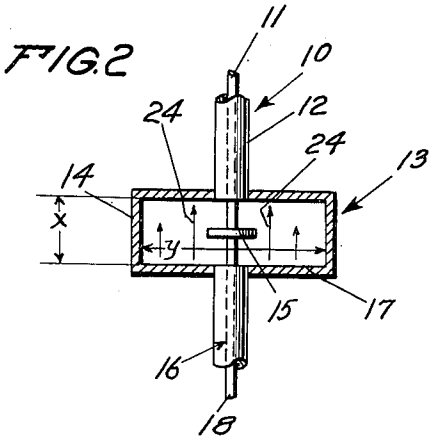


FIG. 2



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LOW PASS FILTERS

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1 Claim. (Cl. 333—73)

This invention relates to low pass fiters 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_{10}) 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 higher 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 adsorption.

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 reference 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_{10} 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 TE_{10} 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.

References Cited in the file of this patent

UNITED STATES PATENTS

2,088,749	King	Aug. 3, 1937
2,129,712	Southworth	Sept. 13, 1938
2,411,553	Ramo	Nov. 26, 1946
2,514,779	Martin	July 11, 1950
2,580,678	Hansen et al.	Jan. 1, 1952
2,588,226	Fox	Mar. 4, 1952
2,619,639	Isely	Nov. 25, 1952
2,644,889	Finke et al.	July 7, 1953

FOREIGN PATENTS

579,764	Great Britain	Aug. 15, 1946