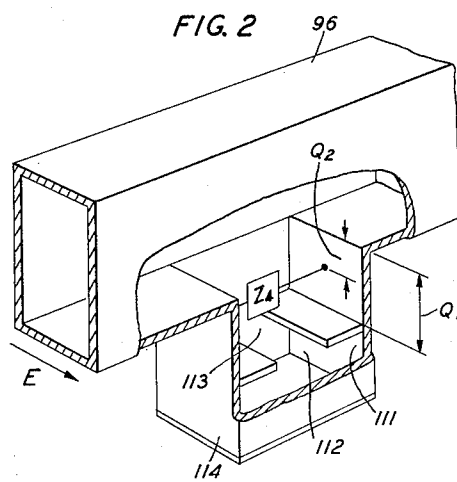
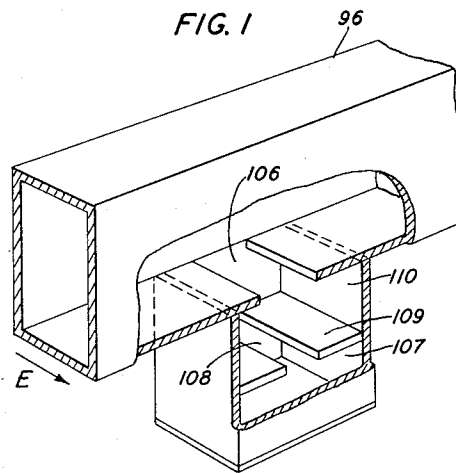


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WAVE FILTER

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## UNITED STATES PATENT OFFICE

2,530,691

## WAVE FILTER

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7 Claims. (Cl. 178-44)

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This invention relates to wave transmission networks and more particularly to frequency selective networks for use in the transmission of guided electromagnetic waves.

The principal object of the invention is to transmit freely a band or bands of electromagnetic waves while effectively blocking waves falling outside of the band or bands. A further object is to improve the transmission characteristics of filters for use in wave guides.

A uniform metallic sheath with or without a dielectric filler will serve as a guide for suitable electromagnetic waves. In cross-section the sheath may be circular, rectangular, or of other shape. For all frequencies above a minimum, known as the cut-off frequency, the guide acts like a transmission line and has a specific propagation constant and characteristic impedance. For any particular frequency there are an infinite number of cross-sectional sizes and shapes of guide which will have the same characteristic impedance. Shunt reactance elements may be obtained by placing partial obstructions across the wave guide. For example, a shunt reactive element for dominant transverse electric waves may be obtained by using a transverse metal partition having a slit therein which extends substantially from one side to the other. If the slit is perpendicular to the direction of polarization of the electric field, the element is primarily capacitive, and if parallel with the field, the element is primarily inductive.

The wave guide filter in accordance with the present invention comprises a plurality of coupled chambers in a single side branch. For example, a first chamber may open into the main wave guide and a second chamber open into the first. The chambers may be formed by introducing one or more apertured transverse partitions into a side branch which is closed at one end and at its other end opens into the main guide. An improvement in the transmission characteristics may be obtained by connecting a reactive impedance branch, preferably variable, across the side branch at a selected point between the first apertured partition and the point of juncture between the branch and the main guide. The filter may be designed either to transmit or to suppress a band of frequencies. The end chamber is tuned to resonate at the desired mid-band frequency. The reactive impedance branch may be adjusted to provide a peak of attenuation, in the case of the band-pass filter, or a transmission peak, in the case of the band-sup-

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pression filter, at a frequency to one side or the other of the mid-band frequency.

This is a continuation in part of application Serial No. 422,408, filed December 10, 1941, now Patent 2,396,044, and a division of application Serial No. 452,851, filed July 30, 1942, now Patent 2,432,093.

The nature of the invention will be more fully understood from the following detailed description and by reference to the accompanying drawings, in which like reference characters refer to similar parts and in which:

Fig. 1 is a perspective view, partly cut away, of a wave guide filter in accordance with the invention comprising two coupled chambers in a single side branch; and

Fig. 2 is a similar view of a modified form of the filter shown in Fig. 1.

Fig. 1 shows a band-suppression wave guide filter in accordance with the invention comprising a side-branch chamber 110, opening into a main wave guide 96 through an aperture 106, and a second chamber 107, coupled to the chamber 110 through an aperture 108 in the transverse partition 109. Each of the chambers 107 and 110 is tuned to resonate at the mid-band frequency. The filter will have two attenuation peaks the spacing between which depends upon the size of the aperture 108.

Fig. 2 shows a wave guide filter using a modified form of side branch 114 which may be designed either to transmit or to suppress a narrow band of frequencies. The branch 114 comprises an end chamber 111 opening through an aperture 112 into a side-branch section 113 of length  $Q_1$  which connects the chamber 111 with the main wave guide 96. Shunted across the section 113 at a distance  $Q_2$  from a side of the main guide 96 is a reactive impedance branch  $Z_4$ . This branch may, for example, comprise a capacitive reactor or an inductive reactor. A suitable variable capacitive reactor is shown in Fig. 8 of my above-mentioned Patent 2,432,093 and an appropriate variable inductive reactor is shown in Fig. 9 thereof. If the reactance  $Z_4$  is omitted, the transmission or suppression characteristic, as the case may be, will in general be unsymmetrical.

The adjustment of the filter of Fig. 2 for the transmission of a narrow band of frequencies is as follows: First, the end chamber 111 is tuned to resonate at the desired mid-band frequency. Then the length  $Q_1$  of the section 113 is adjusted until waves of the mid-band frequency traveling through the main guide 96 are freely transmitted. In general the narrower the aper-

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ture 112 is made, the sharper will be the transmission band.

If it is desired to obtain a peak of attenuation at one side or the other of the transmission band, the impedance branch  $Z_4$  is introduced. The distance  $Q_2$  is determined by finding experimentally a point of standing wave voltage minimum in the section 113. The frequency of the waves is now changed to the desired frequency and the magnitude of the reactance  $Z_4$  adjusted to produce a peak of attenuation. On the other hand, if a symmetrical characteristic having maximum possible attenuation on either side of the transmission band is desired, the value of  $Z_4$  is found first for a frequency at a certain distance to one side of the mid-band and then for a second frequency the same distance to the other side of the mid-band. The reactance  $Z_4$  is then set at the average of the two values thus determined.

For a band suppression characteristic the adjustment is the same as just described except that the length  $Q_1$  is adjusted for reflection of power at the mid-band frequency and  $Z_4$  may be adjusted for a transmission peak at a frequency to one side or the other of the mid-band.

In each of the figures the wave guide 96 is assumed to be transmitting electromagnetic waves having their electric field polarized in the direction indicated by the arrow E.

What is claimed is:

1. In combination, a transmission line in the form of a hollow wave guide adapted for the through transmission of electromagnetic waves and a wave filter, said wave guide comprising an input section and an output section connected in tandem, said filter comprising a side branch closed at one end and at its other end opening into said wave guide at the junction of said input and output sections, an apertured transverse partition positioned at an intermediate point in said branch to form an end chamber tuned to resonate at approximately the mid-band frequency of said filter, and a reactive shunt impedance branch located in said side branch between said partition and said wave guide at a point of standing wave voltage minimum for said mid-band frequency, whereby waves of one fre-

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quency will be freely transmitted from said input section to said output section but waves of a different frequency will be effectively prevented from passing from said input section to said output section.

2. The combination in accordance with claim 1 in which said reactive shunt impedance branch comprises a variable capacitive reactor.

3. The combination in accordance with claim 1 in which said reactive shunt impedance branch comprises a variable inductive reactor.

4. The combination in accordance with claim 1 in which the distance between said partition and said wave guide is so chosen that waves of said mid-band frequency are freely transmitted from said input section to said output section.

5. The combination in accordance with claim 4 in which the magnitude of the reactance of said shunt impedance branch is chosen to produce a peak of attenuation at a frequency near said mid-band frequency.

6. The combination in accordance with claim 1 in which the distance between said partition and said wave guide is so chosen that waves of said mid-band frequency are reflected in said wave guide.

7. The combination in accordance with claim 6 in which the magnitude of the reactance of said shunt impedance branch is chosen to produce a transmission peak at a frequency near said mid-band frequency.

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