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BAND-PASS WAVEGUIDE FILTERS EMPLOYING
TRANSMISSION TYPE RESONANT IRISES

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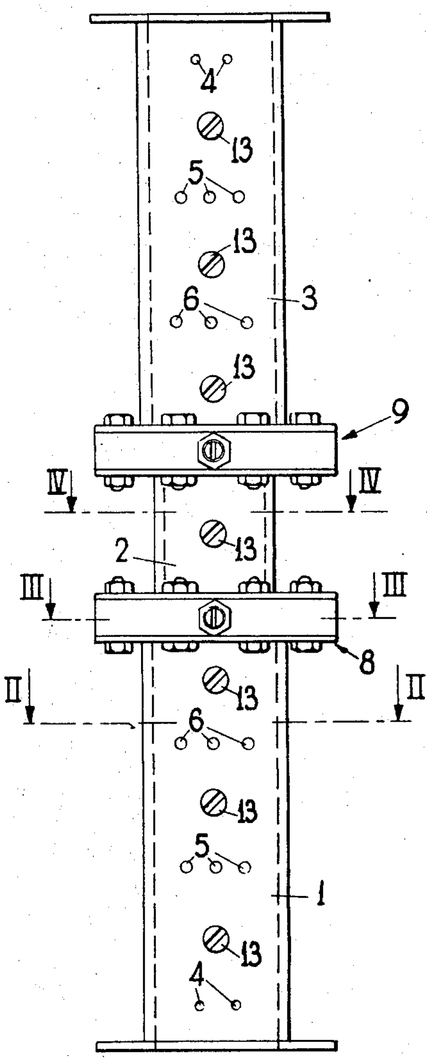

Fig.1.

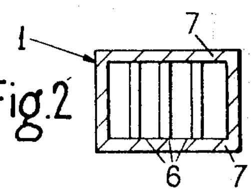

Fig.2

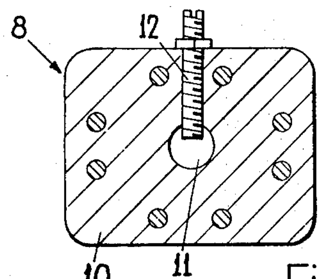

Fig.3

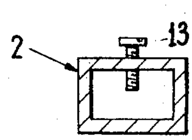

Fig.4

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BAND-PASS WAVEGUIDE FILTERS EMPLOYING TRANSMISSION TYPE RESONANT IRISES

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ABSTRACT OF THE DISCLOSURE

A waveguide band-pass filter having two resonant irises spaced a quarter wavelength apart at a frequency in the pass band. The waveguide on each side of these irises contains sets of posts which are also spaced a quarter wavelength apart at the said frequency. The resonant irises are tuned to a frequency outside the pass band so that they each provide a capacitive shunt at frequencies above the required pass band.

This invention relates to waveguide filters.

More particularly the invention is concerned with waveguide filters of the kind having a band-pass characteristic over a range of frequencies and in which a waveguide path is effectively shunted at spaced points along the path by reactances that are provided by obstructions in that path.

A known form of band-pass filter comprises a length of waveguide of rectangular cross-section in which obstructions in the form of posts are provided at points along the waveguide, the electrical distance between adjacent points being approximately a half wavelength at frequencies in the required pass band. Since these points are also spaced apart by distances equal to a plurality of half wavelengths at various higher frequencies, this construction of filter has an attenuation/frequency characteristic that contains a succession of unwanted pass bands. At frequencies outside these pass bands, a signal passed through the filter is attenuated by the shunt inductive reactance presented by the posts but it will be appreciated that as the frequency increases the shunting effect of these posts is correspondingly reduced. In other words the maximum attenuation to which a signal may be subjected falls off with increasing frequency and one object of the present invention is to provide a construction of waveguide filter in which this situation is improved.

For the purpose of minimising those defects of the known form of band-pass filter discussed in the last paragraph, it is known for it to be used in conjunction with a low-pass filter which has a pass band containing the pass band of the band-pass filter. Another object of the present invention is to provide a construction of band-pass filter which has a characteristic such that no additional low-pass filter is needed to provide the necessary attenuation at frequencies above the required pass band.

According to the present invention, in a waveguide filter of the kind specified at least one of said obstructions is in the form of a transmission resonant iris the resonant frequency of which is outside the required pass band.

According to a feature of the present invention, in a waveguide filter which comprises a waveguide path of rectangular (but not necessarily uniform) cross-section having a plurality of obstructions in that path, the electrical distance between these obstructions being approximately a half wavelength at frequencies in a pass band of the filter, two or more of said obstructions are provided by transmission resonant irises the resonant frequency of each of which is outside said pass band while the rest of said obstructions are provided by posts.

In one form of filter as set out in the last paragraph, there are only two transmission resonant irises which constitute adjacent obstructions and some of said posts lie on either side of the resonant irises. If the waveguide path is of uniform cross-section along its length, there is still a tendency for the filter to have unwanted pass bands, as previously discussed herein, although these bands are now very narrow. The attenuation/frequency characteristic of the filter outside the required pass band may be improved to reduce this effect by having the length of waveguide of the waveguide path between the transmission resonant irises of different cross-section (that is to say different cross-sectional shape and/or different dimensions) to the lengths of waveguide on either side thereof.

One example of a band-pass filter in accordance with the invention will now be described with reference to the accompanying drawings in which:

FIG. 1 shows a plan view of the complete filter, and

FIGS. 2, 3 and 4 show cross-sectional views at the lines II—II, III—III and IV—IV respectively in FIG. 1.

Referring now to FIG. 1 of the accompanying drawings the filter is formed by three waveguides **1**, **2** and **3** which are co-linear. The waveguides **1** and **3** are identical and are of uniform rectangular cross-section while the waveguide **2**, which lies between the waveguides **1** and **3**, is also of uniform rectangular cross-section although its cross-sectional dimensions are somewhat smaller than those of the waveguides **1** and **3**.

Each of the waveguides **1** and **3** contains three sets of posts **4**, **5** and **6** that are spaced along it as in known waveguide filters. Referring now also to FIG. 2, the posts **6**, for example, extend right across the waveguide **1** or **3** normal to the major walls **7** thereof.

Two resonant irises **8** and **9** are connected between the waveguides **1** and **3** respectively on one hand and the waveguide **2** on the other hand, each of these irises being formed by an apertured plate. As shown in FIG. 3, the iris **8**, for example, is provided by a metal plate **10** that has a circular aperture **11** through it, there being a screw **12** projecting into the aperture **11** for the purpose of tuning the iris. It will be apparent that the iris shown in FIG. 3 is a transmission resonant iris, that is, an iris which has minimum attenuation at its resonance frequency. It thus may be considered as a parallel LC circuit across the transmission line.

The two resonant irises **8** and **9** are identical and each has a resonant frequency that is higher than the required pass band of the filter. Thus, at frequencies in that band, each of these irises **8** and **9** presents an inductive shunt across the waveguide path formed by the waveguides **1**, **2** and **3**. The posts **4**, **5** and **6** also provide inductive shunts across this waveguide path. The resonant irises **8** and **9** and the posts **4**, **5** and **6** are arranged in known manner to give the filter the desired band-pass characteristic, the obstructions presented by the irises **8** and **9** and sets of posts **4**, **5** and **6** being spaced along the waveguide path so that the electrical distance between adjacent pairs thereof is approximately equal to a half wavelength at the mid-frequency of the required pass band. Tuning screws **13** (see also FIG. 3) are provided in known manner between each adjacent pair of these obstructions so as to enable these electrical distances to be slightly adjusted.

As far as the pass band is concerned, the attenuation/frequency characteristic of the filter is essentially the same as if the resonant irises **8** and **9** were replaced by posts although at a somewhat higher frequency the irises do give rise to a slight hump of reduced attenuation in the characteristic at the resonant frequency thereof. It will be appreciated that at frequencies above the resonant frequency of the irises **8** and **9**, they each present a capacitive shunt across the waveguide path, this shunting effect increasing with frequency thereby tending to increase the filter's attenuation at such frequencies.

It is well known that the electrical distance between two points along a waveguide is a function of both frequency and the cross-sectional dimensions of the waveguide. To satisfy the conditions discussed above, and remembering that the waveguide **2** is of smaller cross-section that the waveguides **1** and **3**, it is necessary for the effective physical distance between the two resonant irises **8** and **9** to be somewhat greater than that between the sets of posts **4**, **5** and **6** in the waveguides **1** and **3**. Furthermore the waveguide path is so dimensioned that, at the next higher band of frequencies (above the required pass band) at which the sets of posts **4**, **5** and **6** would by themselves give rise to an unwanted pass band as previously discussed herein, the electrical distance between the irises **8** and **9** is such that this unwanted pass band is largely suppressed.

In one example of the construction of band-pass filter described above having a required pass band in the region of 6,000 megacycles per second and a band width of about 30 megacycles per second, the resonant frequency of the irises **8** and **9** is approximately 6,500 megacycles per second. Some of the dimensions of the filter are as follows:

Cross-section of waveguides **1** and **3**: 1.37 ins. by 0.62 ins.
Cross-section of waveguide **2**: 1.12 ins. by 0.50 ins.
Physical distances between set of posts **6** and adjacent end of waveguide **1** (or **3**): 1.50 inches
Physical distance between sets of posts **4** and **5**: 1.38 inches
Physical distance between sets of posts **5** and **6**: 1.55 inches
Physical length of waveguide **2**: 1.69 inches
Width of plate **10**: 0.375 inch
Diameter of aperture **11**: 0.375 inch
Diameter of tuning screw **12**: 0.140 inch

Although in the embodiment described above the resonant frequency of the two irises **8** and **9** is above the required pass band of the filter, it is to be understood that alternatively the resonant frequency may be below the required pass band. No other physical changes in the filter are necessary. In some cases this arrangement is preferable to the form previously described since it gives rise to a more symmetrical amplitude response in the region of the required pass band.

Furthermore, instead of the waveguide **2** being of smaller cross-sectional dimensions than the waveguides **1** and **3** and of greater length than the physical distance between the sets of posts **5** and **6**, for example, the waveguide **2** may alternatively and for the same reason be of greater cross-sectional dimensions than the waveguides **1** and **3** and of shorter length than the physical distance between the sets of posts **5** and **6**.

We claim:

1. A waveguide filter of the kind having a band-pass

characteristic over a range of frequencies and in which a waveguide path is effectively shunted at spaced points along the path by reactances that are provided by obstructions in that path wherein at least one of said obstructions is in the form of a transmission resonant iris the resonant frequency of which is outside the required pass band.

2. A waveguide filter according to claim **1** wherein those of said obstructions that are not provided by a transmission resonant iris or irises are provided by posts.

3. A waveguide filter which comprises a waveguide path of rectangular cross-section having a plurality of obstructions in that path, the electrical distance between these obstructions being approximately a half wavelength at frequencies in a pass band of the filter, wherein two or more of said obstructions are provided by transmission resonant irises the resonant frequency of each of which is outside said pass band while the rest of said obstructions are provided by posts.

4. A waveguide filter according to claim **3** wherein there are only two transmission resonant irises which constitute adjacent obstructions and some of said posts lie on either side of the resonant irises.

5. A waveguide filter according to claim **4** wherein the length of waveguide of the waveguide path between the transmission resonant irises is of different cross-section to the waveguide on either side thereof so as to improve the attenuation/frequency characteristic of the filter outside the required pass band.

6. A waveguide filter according to claim **5** wherein said length of waveguide between the transmission resonant irises is of smaller cross sectional dimensions than the lengths of waveguides on either side thereof and of greater physical length than the distance between adjacent sets of posts in those lengths of waveguide.

7. A waveguide filter according to claim **5** wherein said length of waveguide between the transmission resonant irises is of greater cross-sectional dimensions than the lengths of waveguide on either side thereof and of shorter physical length than the distance between adjacent sets of posts in those lengths of waveguide.

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U.S. Cl. X.R.

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