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[54] **WAVEGUIDE REFLECTIVE HARMONIC FILTER**
6 Claims, 3 Drawing Figs.

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[50] Field of Search .... 333/70, 73, 73 W, 76, 98, 98 M, 83

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ABSTRACT: A waveguide reflective harmonic filter is disclosed. The filter includes a primary hollow waveguide to be connected in circuit between a source of microwave energy and a load. An array of secondary waveguides are coupled through the walls of the primary guide, such secondary waveguides being resonant for reflecting harmonic band energy toward the source. The array of secondary waveguides includes a first portion of the array being resonant within the second harmonic, a second portion being resonant within the third harmonic band and a third portion being resonant within the fourth harmonic band. A septum, parallel to the broad walls of the primary guide, divides the primary guide into two parallel sections to improve the power handling capability and to suppress certain undesired modes.

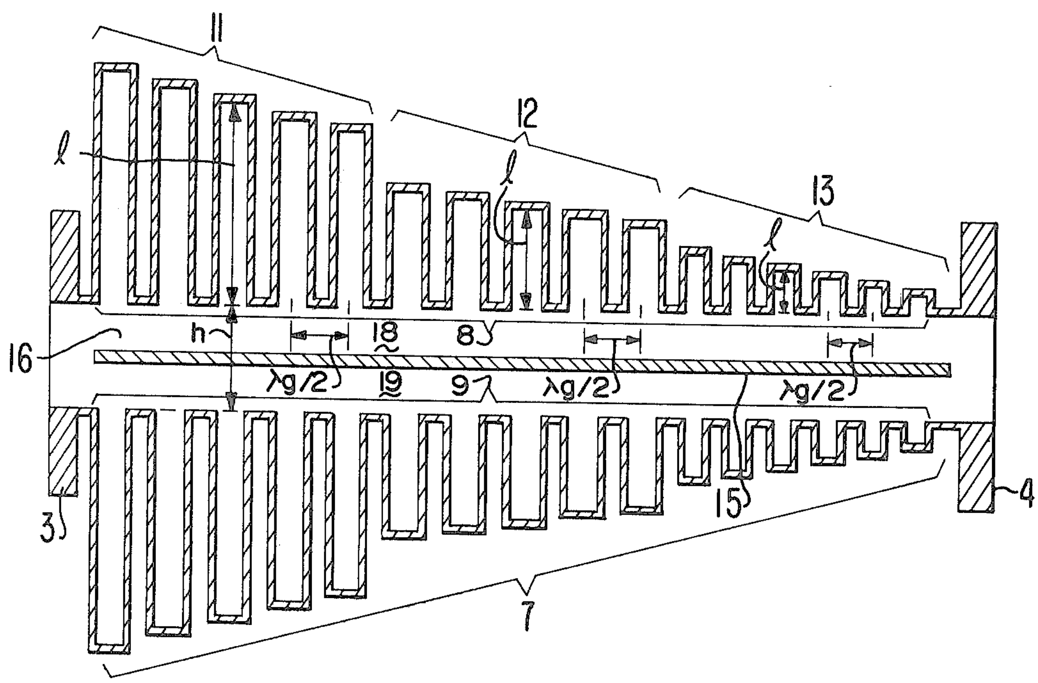


FIG. 1

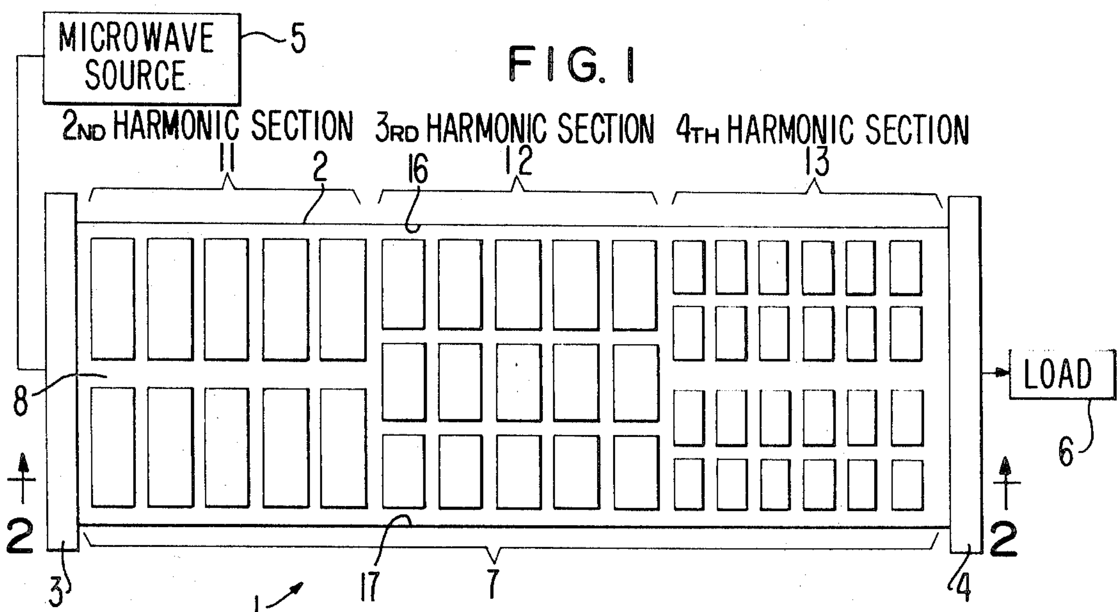


FIG. 2

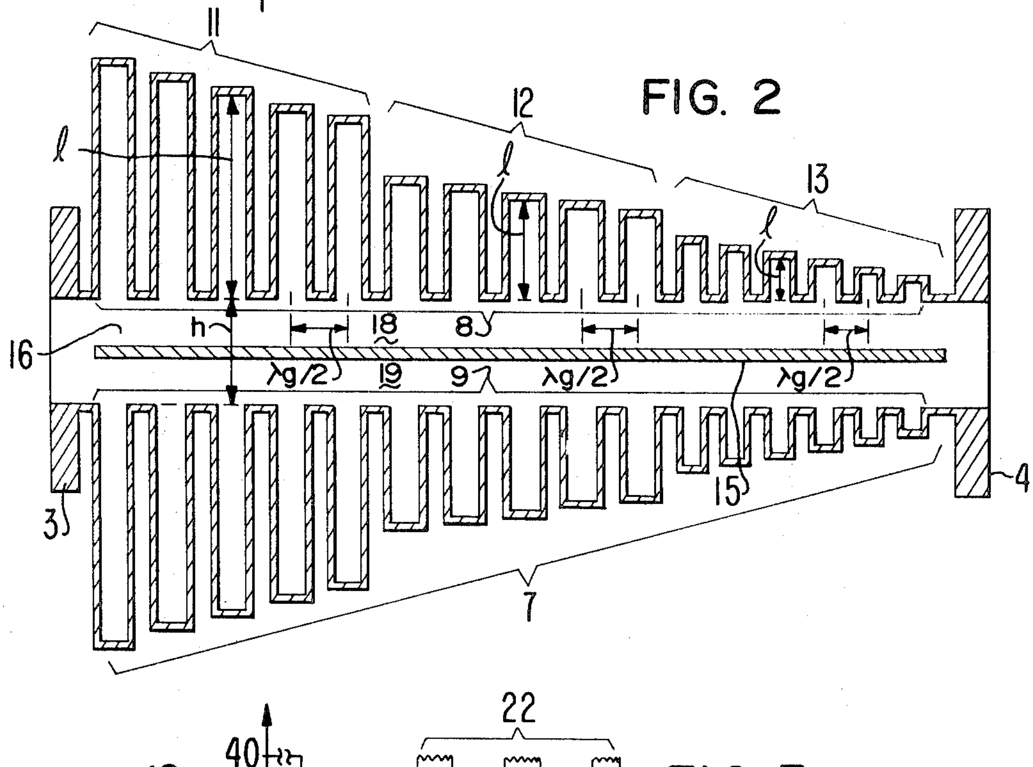
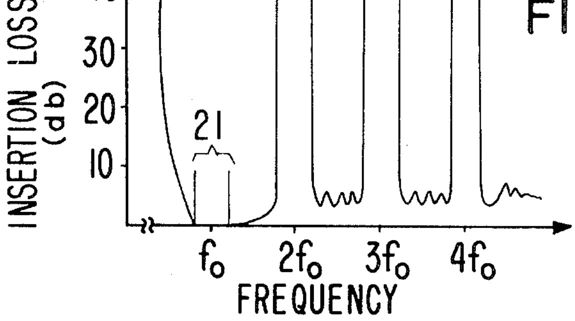


FIG. 3



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WAVEGUIDE REFLECTIVE HARMONIC FILTER

DESCRIPTION OF THE PRIOR ART

Heretofore, waveguide reflective harmonic filters have been built wherein an array of secondary waveguide, such secondary waveguides being resonant at the second harmonic for reflecting second harmonic wave energy toward the source. In such an arrangement the primary guide had a tapered height which tapered to a substantially reduced height intermediate the ends of the primary guide to discriminate against setting up certain modes of propagation associated with wave energy traveling on the narrow walls of the primary guide with the electric field vector being parallel to the broad walls of the guide. The problem with this prior art filter was that it had limited power handling capability due to the reduction in height of the primary guide and the reflective filter did not reflect harmonics higher than the second.

SUMMARY OF THE PRESENT INVENTION

The principle object of the present invention is the provision of an improved waveguide reflective harmonic filter.

One feature of the present invention is the provision of a waveguide reflective harmonic filter having an array of resonant secondary waveguides coupled through the walls of a primary guide and wherein the array of secondary waveguides includes first, second and third portions being resonant at the second, third and fourth harmonic, respectively, of the fundamental passband of the filter.

Another feature of the present invention is the same as the preceding feature wherein a conductive septum is disposed within the primary guide, such septum being disposed generally parallel to the broad walls and extending between and interconnecting the narrow walls to short out certain undesired modes of propagation having electric field vectors perpendicular to the narrow walls of the primary guide.

Another feature of the present invention is the same as any one or more of the preceding features wherein the resonant secondary waveguides are tuned to different frequencies within each of the respective harmonic bands for broadbanding the filter.

Other features and advantages of the present invention will become apparent upon perusal of the following specification taken in connection with the accompanying drawings wherein:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of a filter of the present invention as shown connected in circuit between a source and a load, shown in schematic block diagram form,

FIG. 2 is a sectional view of the structure of FIG. 1 taken along line 2—2 in the direction of the arrows, and

FIG. 3 is a plot of insertion loss versus frequency depicting the performance characteristics of the filter of FIGS. 1 and 2.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIGS. 1 and 2, there is shown the filter 1 of the present invention. Waveguide reflective harmonic filter 1 includes a length of hollow rectangular waveguide 2 preferably having a height, h, equal to the normal height waveguide for the fundamental frequency of the filter, such as S-band. Waveguide flanges 3 and 4 are provided at opposite ends of the primary waveguide 2 for connection of the filter 1 to a source of microwave energy 5, such as a high power S-band klystron amplifier or magnetron oscillator having a power output of 2 megawatts peak and to a microwave load 6, such as an antenna, respectively.

The filter 1 includes an array of secondary waveguides 7 coupled to the primary waveguide 2 through the top and bottom broad walls 8 and 9, respectively, of the primary guide 2. The array of secondary waveguides 7 is divided into 3 portions, a second harmonic portion 11, a third harmonic portion 12, and a fourth harmonic portion 13, arranged in successive sections along the length of primary guide 2. The secondary waveguides 7 are dimensioned to be cut off for the fundamental band frequencies to be propagated through the primary guide 2 such as not to interfere with the transmission of the fundamental band wave energy through the filter 1.

The secondary waveguides 7 are short circuited at their outer ends to form quarter wave resonators within the second harmonic band, the third harmonic band and the fourth harmonic band, respectively, of the filter. More particularly, the resonators 7 which are midway along the length of each of the respective portions 11, 12 and 13 are dimensioned to have a length which is approximately a quarter wavelength long at the center of the respective harmonic band. The other resonators within each portion of the array have lengths which taper from 110 percent of the length of the midresonator to 90 percent of the length of the midresonator such that the resonators in each of the portions of the total array are tuned to different frequencies over the band of each of the harmonics to obtain broad band operation of the filter 1.

The second harmonic resonators 11 are arranged in a pair of rows on each of the broad walls of the guide 2, whereas the third harmonic resonators of the third portion 12 are arranged in three rows on each of the top and bottom walls of the waveguide 2 and the fourth harmonic resonators 13 are arranged in four rows on each of the top and bottom walls of the waveguide 2. The resonators are axially spaced, on their centers, along the length of the primary guide by approximately one half of a guide wavelength at the respective harmonic within the primary guide such that the respective harmonic power reflected by that portion of the array is additive in the reflective direction back toward the microwave source 5. The secondary waveguides 7 need not be of standard height for the respective harmonic but may be of reduced height, i.e., their broad dimension may be substantially greater than twice the narrow or height dimension.

A conductive septum 15 is disposed midway between the top and bottom walls 8 and 9 of the primary guide 2 and extends parallel to the top and bottom walls interconnecting the narrow walls 16 and 17 of the primary guide. The septum serves to short out the transmission modes having electric field vectors parallel to the broad walls of the primary guide 2, thereby purifying the desired transmission mode through the waveguide 2. In addition, the septum 15 divides the primary waveguide 2 into two parallel waveguiding sections 18 and 19 on opposite sides of the septum 15, each parallel waveguiding section 18 and 19 having a height of approximately 35 percent of the normal height of a standard waveguide to further discriminate against undesired transmission modes having electric field vectors parallel to the broad walls of the primary waveguide 2. The resultant two parallel waveguiding sections 18 and 19 substantially improve the power handling capability of the filter 1. More particularly, the septum 15 permits the power handling capability of the filter to be substantially double that of the prior art design which did not include the septum. The primary guide 2 is typically pressurized with a gas which is not readily ionizable, such as air to a suitable pressure as of 30 p.s.i.g. to minimize the arcing at high power levels.

Referring now to FIG. 3, there is shown a typical filter characteristic for filters of the present invention. More particularly, the plot of FIG. 3 shows insertion loss in db. versus frequency within the fundamental band of frequencies 21 centered about F_0, such as S-band. The insertion loss is on the order of a fraction of a db. whereas within the band of frequencies including the second, third and fourth harmonic, indicated at 22, the insertion loss is above 40 db.

Thus far in the description of the present invention the secondary waveguides are shown coupled through the broad walls of the guide 2; this is not a requirement and in other embodiments the secondary waveguides may be coupled through the narrow walls 16 and 17 of the primary guide 2.

Since many changes could be made in the above construction and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. In a microwave waveguide reflective filter, means forming a hollow primary waveguide to be connected in circuit between a source of microwave energy and a load, the microwave energy from the source being characterized by having a desired fundamental mode of energy at a frequency within a fundamental passband of frequencies and having undesired harmonic energy within harmonic frequency bands of the fundamental passband, said primary waveguide being dimensioned to be cut off for frequencies below the fundamental passband for transmission of the fundamental mode energy to the load, means forming an array of resonant secondary waveguides dimensioned to be cut off for the fundamental mode energy and to be above cutoff for the frequencies of the harmonic bands, said secondary waveguides being coupled through the walls of said primary waveguide to the harmonic microwave energy in said primary waveguide for reflecting harmonic band energy toward the microwave source, the improvement wherein, said array of secondary waveguides includes a first portion of said array being resonant within the second harmonic band, a second portion of said array being resonant within the third harmonic band, and a third portion of said array being resonant within the fourth harmonic band, said resonant secondary waveguides being tuned to different frequencies within each of the harmonic bands for broadbanding the filter.

2. The apparatus of claim 1 wherein said primary waveguide is a rectangular waveguide having a pair of opposed broad walls interconnected by a pair of narrow walls, and means forming a conductive structure disposed within said waveguide and extending substantially parallel to said broad walls and interconnecting said narrow walls to shot out certain undesired modes of propagation having electric field vectors perpendicular to said narrow walls of said primary waveguide.

3. The apparatus of claim 1 wherein said resonant secondary waveguides are tuned to different frequencies by having different lengths.

4. The apparatus of claim 1 wherein certain ones of said secondary waveguides within the same portion of said array are spaced center to center along the axis of said primary waveguide by one-half a guide wavelength for wave energy at the respective harmonic for which said respective secondary waveguides are resonant.

5. The apparatus of claim 1 wherein said primary waveguide is a rectangular waveguide having a pair of opposed broad walls interconnected by a pair of narrow sidewalls, said first portion of said array of secondary waveguides including a pair of rows of secondary waveguides coupled through each of said broad walls of said primary guide, said second portion of said array of secondary waveguides including three rows of secondary waveguides coupled through each of said broad walls of said primary waveguide, and said third portion of said array of secondary waveguides including four rows of secondary waveguides coupled through each of said broad walls of said primary waveguide.

6. The apparatus of claim 5 including a conductive septum disposed within said waveguide and extending substantially parallel to said broad walls and interconnecting said narrow walls to short out certain undesired modes of propagation having electric field vectors perpendicular to said narrow walls of said primary waveguide.