Nov. 14, 1967 H. H. MANOOCHEHRI 3,353,122

WAVEGUIDE FILTERS HAVING ADJUSTABLE TUNING MEANS IN NARROW WALL OF WAVEGUIDE

Filed Aug. 21, 1963

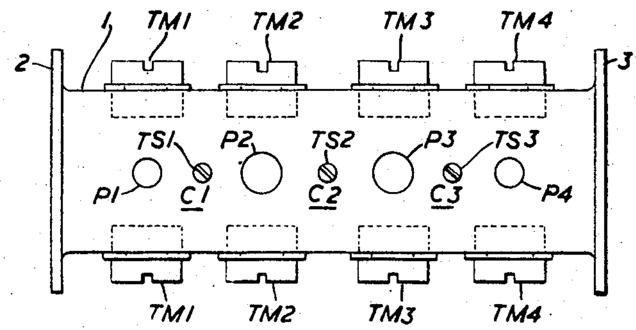

FIG. 1.

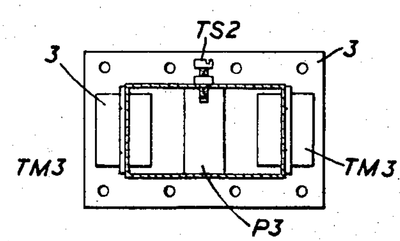

FIG. 2.

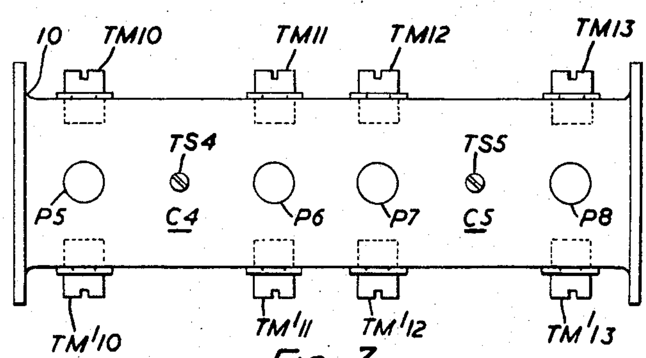

FIG. 3.

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United States Patent Office

3,353,122
Patented Nov. 14, 1967

3,353,122

WAVEGUIDE FILTERS HAVING ADJUSTABLE TUNING MEANS IN NARROW WALL OF WAVEGUIDE

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Filed Aug. 21, 1963, Ser. No. 303,481
Claims priority, application Great Britain, Aug. 24, 1962, 32,632/62
10 Claims. (Cl. 333—73)

This invention relates to waveguide filters and more particularly to waveguide filters of the kind comprising a length of waveguide of rectangular cross-section having therein at least one effectively resonant length whose ends are defined by conductive posts extending between and in contact with the broad faces of the guide. In such filters the operating frequency is determined, inter alia, by the cross-sectional dimensions of the conductive posts which place a limit on the frequency range over which the filter may be tuned, with the result that such filters as at present known suffer from the defect that they may be tuned over only a relatively narrow frequency band. It is the object of the present invention to provide improved waveguide filters of the kind referred to which shall be free of this defect.

According to this invention a waveguide filter of the kind referred to is provided with at least one conductive member alongside each conductive post and adapted adjustably to extend into said guide from a narrow face thereof towards or away from said post.

Preferably there are two conductive members extending from opposite narrow faces towards the same post and preferably also each conductive member is constituted by a metallic screw screwed into the guide wall.

A filter in accordance with the invention may comprise a number of effectively resonant lengths of waveguide which may be immediately adjacent one another or, spaced apart by quarter wave coupling sections of waveguide.

Preferably each resonant length of waveguide is provided in known manner with a conductive tuning member position between said posts and extending into the guide through one of its broad faces.

The invention is further described with reference to and illustrated in the accompanying drawing in which FIGURES 1 and 2 are mutually perpendicular views of a preferred embodiment of waveguide filter in accordance with the invention, FIGURE 2 being a cross-sectional view taken on the centre line of FIGURE 1, while FIGURE 3 shows a further embodiment.

Referring to FIGURES 1 and 2, the waveguide filter therein shown comprises a length 1 of waveguide of rectangular cross-section having end flanges 2 and 3. The waveguide length 1 includes three resonant lengths or cavities C1, C2 and C3 each having a nominal length of half a guide wavelength at the operating frequency, the ends of each length or cavity being defined by conductive posts which extend between and are fixed in contact with the broad faces of the waveguide. The conductive posts are thus arranged parallel to the electric field excited in the waveguide at the dominant H_{01} mode propagated therein. Thus cavity C1 is terminated by the posts P1 and P2, cavity C2 by posts P2 and P3 and cavity C3 by posts P3 and P4. Each of the posts P2 and P3 thus acts as a terminating post for two adjacent resonant lengths or cavities and provides coupling therebetween. As is apparent from the drawing, posts P2 and P3 are larger in diameter than posts P1 and P4 while the length of cavity C2 is greater than the lengths of cavities C1 and C3. The dimensioning of the lengths of

the cavities and the diameters of the posts is in accord with well known practice and does not require further description here.

Centrally situated between adjacent pairs of posts are capacitive tuning screws TS1, TS2 and TS3 each of which is in conductive contact with and adjustably extends through a broad face of waveguide 1 into the interior of the guide.

As so far described the waveguide filter is a band pass filter whose operating frequency is adjustable within certain small limits by means of the adjustment of screws TS1, TS2 and TS3 whose adjustment, as is well known also permits the achievement of a desired overall band pass characteristic.

In accordance with the invention there is provided alongside each of the posts P1, P2, P3 and P4 a pair of adjustable tuning members constituted by a pair of metallic screws TM1–TM′1, TM2–TM′2, TM3–TM′3 or TM4–TM′4, which are screwed through and are in conductive contact with the narrow faces of the waveguide 1, the axes of each pair of screws and the axis of the associated post lying in a common transverse cross-sectional plane of the guide. By varying the amount by which these pairs of screws extend into the waveguide the operating frequency of the waveguide filter may be adjusted over a wide range of frequencies. In general, it is preferred that the lengths of the resonant lengths or cavities of the filter are chosen to have optimum values at the upper frequency to which the filter is to be tuned, while the diameters of the posts P1, P2, P3 and P4 are chosen to have optimum values at the lower frequency of the range of tuning of the filter. Thus with the pairs of screws TM1–TM′1, TM2–TM′2, TM3–TM′3 or TM4–TM′4 adjusted so that their innermost faces are flush with the narrow walls of waveguide 1 the filter is tuned at the lower frequency of its tuning range. As the pairs of screws TM1–TM′1 . . . are screwed into the guide the operating frequency of the filter increases.

Preferably the screws of each pair are adjusted to extend into the guide by equal amounts but this again is not essential so long as the total extension of each pair of screws into the guide is at a desired value.

Although in practice it is preferred that each of the tuning posts is provided with a pair of tuning screws, this again is not essential and a single tuning member positioned in the same cross-sectional plane as its associated post and extending through one of the narrow faces of the waveguide may be used. Such a single tuning member will not, of course, provide tuning over as great a frequency range as will a pair of tuning members.

Furthermore, the greater the cross-sectional dimension of the tuning members in a plane parallel to the longitudinal axis of the waveguide, the greater will be the tuning range over which control may be effected. Accordingly, and as illustrated, each of the tuning screws TM1–TM′1 . . . is made to have as large a diameter as the size of the waveguide will conveniently permit.

As stated above, as the tuning members TM1–TM′1 . . . are extended into the waveguide the operating frequency of the filter is increased but, in practice, it is found that if these tuning members are extended into the waveguide beyond a certain predetermined limit their effect is reversed and the frequency of the filter decreases. This, however, is not a serious defect in practice and it is found that large variations in the tuning of the filter may be obtained before the above effect operates.

In operation when the frequency of the filter has been adjusted to its approximate desired value by means of the pairs of tuning screws TM1–TM′1 . . . final tuning may be carried out in known manner by adjustment of the capacitive tuning screws TS1, TS2 and TS3.

In one practical embodiment of the invention as described above with reference to FIGURES 1 and 2, waveguide 1 had internal dimenisons of 2.37" x 1.12", the lengths of cavities C1, C2 and C3 were 1.75", 2" and 1.75" respectively, the diameters of posts P1, P2, P3 and P4 were 0.184", 0.583", 0.583", and 0.184" respectively and the external diameter of each of the tuning screws TM1–TM'1 . . . was 1.1". By adjustment of the tuning screws TM1–TM'1 . . . this filter was capable of being tuned over frequency range 3,600 mc./s.–4,200 mc./s. In this connection it is worth noting that without the use of tuning members such as the screws TM1–TM'1 . . . provided in accordance with this invention a series of twelve differently dimensioned waveguide filters have been required, to cover the frequency range 3,800 mc./s.–4,200 mc./s.

FIGURE 3 shows a further embodiment of a band-pass waveguide filter in accordance with the invention the filter comprising a waveguide length 10 including therein two resonant lengths or cavities C4 and C5 each having a nominal length of half a guided wavelength at the operating frequency and each having its ends defined by a pair of conductive posts P5 and P6 or P7 and P8. Each post extends between and is fixed in contact with the broad faces of waveguide 10. Posts P6 and P7 are spaced apart in known manner by a distance approximately equal to a quarter of a guide wavelength at the operating frequency of the filter to provide a coupling section between the cavities C4 and C5. In accordance with the invention each post is provided, in the same cross-sectional plane of the waveguide, with a pair of metallic tuning members or screws TM10–TM'10, TM11–TM'11, TM12–TM'12 or TM13–TM'13 which are screwed through and in contact with the narrow faces of waveguide 10. As with the embodiment of FIGURES 1 and 2 adjustment of the extent to which the tuning screws TM10–TM'10 . . . extend into the waveguide provides adjustment of the operating frequency of the filter. Furthermore, cavities C4 and C5 are provided in known manner with capacitive tuning screws TS4 and TS5.

In view of the description already given with regard to the arrangement of FIGURES 1 and 2 it is believed that no further description of this embodiment of the invention is required, the operation of tuning screws TM10–TM'10 . . . being similar to that of the tuning screws TM1–TM'1 . . . of the embodiment of FIGURES 1 and 2.

I claim:

1. A waveguide filter comprising a length of rectangular waveguide having a pair of opposing broad faces joined together by a pair of opposing narrow faces, a pair of spaced conductive inductive posts, each extending fully between and in contact with said broad faces and positioned to lie generally parallel to the electric field upon excitation of the filter, said conductive posts being spaced to define a resonant length within said waveguide between said posts, and a plurality of adjustable conductive members each attached to a narrow face of said waveguide adjacent to a corresponding conductive post and movable within said waveguide toward and away from the corresponding conductive post to adjust the resonant frequency of said resonant length within said waveguide.

2. A waveguide filter as defined in claim 1 wherein a pair of adjustable conductive members are provided adjacent to each of said conductive posts, one of said adjustable conductive members being attached to a narrow face of said waveguide on one side of said conductive post, and the other adjustable conductive member being attached to the opposing narrow face of said waveguide on the other side of said conductive post.

3. A waveguide filter as defined in claim 1 and also including additional spaced conductive posts extending between and in contact with said broad faces, said first mentioned conductive posts and said additional conductive posts being spaced to define at least two resonant lengths within said waveguides between adjacent pairs of said conductive posts with said two resonant lengths being immediately adjacent one another.

4. A waveguide filter as defined in claim 1 and also including additional spaced conductive posts extending between and in contact with said broad faces, said first mentioned conductive posts and said additional conductive posts being spaced to define at least two resonant lengths and a quarter wave coupling length within said waveguide between adjacent pairs of said conductive posts, said two resonant lengths being spaced apart by said quarter wave coupling length.

5. A waveguide filter as defined in claim 1 and also including a conductive tuning member positioned between said conductive posts and extending into said waveguide through one of said broad faces thereof.

6. A waveguide filter as defined in claim 1 wherein each of said adjustable conductive members comprises a metallic screw engaged in a threaded opening formed in said narrow face adjacent to said corresponding conductive post, and means for moving each of said adjustable conductive members comprising means on the outer end of each of said screws for engaging a screwdriver.

7. A waveguide filter as defined in claim 2 wherein each of said adjustable conductive members comprises a metallic screw engaged in a threaded opening formed in said narrow face adjacent to said corresponding conductive post, and means for moving each of said adjustable conductive members comprising means on the outer end of each of said screws for engaging a screwdriver.

8. A waveguide filter as defined in claim 3 wherein each of said adjustable conductive members comprises a metallic screw engaged in a threaded opening formed in said narrow face adjacent to said corresponding conductive post, and means for moving each of said adjustable conductive members comprising means on the outer end of each of said screws for engaging a screwdriver.

9. A waveguide filter as defined in claim 4 wherein each of said adjustable conductive members comprises a metallic screw engaged in a threaded opening formed in said narrow face adjacent to said corresponding conductive post, and means for moving each of said adjustable conductive members comprising means on the outer end of each of said screws for engaging a screwdriver.

10. A waveguide filter as defined in claim 2 and also including a conductive tuning member positioned between said conductive posts and extending into said waveguide through one of said broad faces thereof.

References Cited

UNITED STATES PATENTS

2,510,288	6/1950	Lewis	333—73
2,518,092	8/1950	Sunstein et al.	333—73
2,531,447	11/1950	Lewis	333—73
2,540,488	2/1951	Mumford	333—73
2,585,563	2/1952	Lewis et al.	333—73
2,594,037	4/1952	Landon et al.	333—73
2,645,679	7/1953	Reade	333—73
2,686,902	8/1954	Tillotson	333—73
2,749,523	6/1956	Dishal	333—73
3,164,792	1/1965	Georgiev et al.	333—73

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