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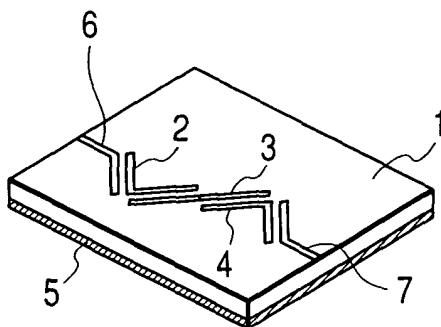
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(54) **Bandpass filter**

(57) The electromagnetic coupling of adjacent lines (lines alternately adjacent to each other) is to be reduced to prevent an attenuation amount from increasing on the low pass side of a passband, and the skirt characteristics are to be steep. A dielectric substrate (1); a plurality of strip line resonators (2, 3, 4) formed on the dielectric substrate as electromagnetically coupled to each other with the both ends opened; and two trans-

mission lines (6, 7) formed on the dielectric substrate for connecting external circuits are provided, in which at least one or more of the strip line resonators is bent at the center part in the length direction. Therefore, the electromagnetic coupling between the lines disposed alternately is reduced, the passband is flat, and the skirt characteristics in the frequency band lower than the passband are steep.

FIG. 1



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a bandpass filter configured of strip line resonators formed on a dielectric substrate.

2. Description of the Related Art

[0002] Fig. 5 depicts a traditional bandpass filter. Strip line resonators 22, 23 and 24 are formed on the top of a dielectric substrate 21 so as to be in parallel with each other. The length of each of the strip line resonators 22 to 24 has nearly a half-wave length of a transmission signal, and the adjacent strip line resonators are disposed so as to be electromagnetically coupled in the portions of a half of the length each other. In addition, a ground conductor 25 is disposed on the underside of the dielectric substrate 21. Then, transmission lines 26 and 27 for connecting external circuits are disposed so as to be electromagnetically coupled to the strip line resonators 22 and 24 disposed on both sides, thereby configuring the bandpass filter as a whole (see, Patent Document 1).

[Patent Document 1]

[0003] JP-A-5-121903 (Fig. 2)

SUMMARY OF THE INVENTION

[0004] In the traditional bandpass filter described above, since each of the strip line resonators and the transmission lines are in parallel with each other, the adjacent lines including the transmission lines (the lines alternately adjacent to each other) are also electromagnetically coupled to deteriorate the passband characteristics. As shown in Fig. 6, there are problems that attenuation R on the low pass side is greater than that on the high pass side of the passband and the skirt characteristics are gentle as well.

[0005] An object of the invention is to reduce the electromagnetic coupling of adjacent lines (lines alternately adjacent to each other) to prevent an attenuation amount from increasing on the low pass side of the passband, and to make the skirt characteristics steep as well.

[0006] As a means for solving the problems, the invention has a dielectric substrate; a plurality of strip line resonators formed on the dielectric substrate as electromagnetically coupled to each other with both ends opened; and two transmission lines formed on the dielectric substrate for connecting external circuits, wherein at least one or more of the strip line resonators is bent at a center part in a length direction.

[0007] Preferably, at least two or more of the strip line resonators are bent, and lines connecting the both ends of the bent strip lines are in parallel with each other.

[0008] Preferably, the bent angle is an angle of about 90°.

[0009] As described above, the bandpass filter according to the invention has the dielectric substrate; a plurality of the strip line resonators formed on the dielectric substrate as electromagnetically coupled to each other with the both ends opened; and two transmission lines formed on the dielectric substrate for connecting external circuit, wherein at least one or more of the strip line resonators is bent at the center part in the length direction. Accordingly, the electromagnetic coupling between the lines alternately disposed is reduced, the passband is flat, and the attenuation on the low pass side of the passband is decreased. Additionally, the skirt characteristics in the frequency band lower than the passband are steep as well.

[0010] Furthermore, at least two or more of the strip line resonators are bent, and the lines connecting the both ends of the bent strip lines are in parallel with each other. Accordingly, the entire bandpass filter can be configured linearly.

[0011] Moreover, the bent angle is an angle of about 90°. Accordingly, the electromagnetic coupling between the lines disposed alternately is most reduced.

[0012] Embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

Fig. 1 is a perspective view illustrating a bandpass filter according to the invention;

Fig. 2 is a plan view illustrating a first embodiment of the bandpass filter according to the invention;

Fig. 3 is a diagram illustrating the transmission characteristics of the bandpass filter according to the invention;

Fig. 4 is a plan view illustrating the first embodiment of the bandpass filter according to the invention;

Fig. 5 is a perspective view illustrating the traditional bandpass filter; and

Fig. 6 is a diagram illustrating the transmission characteristics of the traditional bandpass filter.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0013] A bandpass filter according to the invention will be described in accordance with Figs. 1 to 4. Fig. 1 depicts a perspective view of a first embodiment, Fig. 2 depicts a plan view of the first embodiment, Fig. 3 depicts the transmission characteristics, and Fig. 4 depicts a plan view of a second embodiment.

[0014] First, in Fig. 1, a dielectric substrate 1 is formed of a ceramic material with small dielectric loss, for example, and a plurality of strip line resonators 2, 3 and 4 (three in Fig. 1) is formed on the top thereof. The length of each of the strip line resonators 2 to 4 has near-

ly a half-wave length of a transmission signal, and the adjacent strip line resonators are so as to be electromagnetically coupled in the portions of a half of the length each other. In addition, a ground conductor 5 is disposed on the underside of the dielectric substrate 1. Then, transmission lines 6 and 7 for connecting external circuits are disposed so as to be electromagnetically coupled to the strip line resonators 2 and 4 disposed on both sides, thereby configuring the bandpass filter as a whole. Signals are inputted to one of the transmission lines 6 and 7, and are outputted from the other.

[0015] Fig. 2 depicts a plan form of the strip line resonators 2, 3 and 4 and the transmission lines 6 and 7 for connecting external circuits, all formed on the dielectric substrate 1. The length of each of the strip line resonators 2 to 4 opened at the both ends thereof is set to have nearly a half-wave length of a transmission signal, and the first strip line resonator 2 and the third strip line resonator 4 are bent at the position of the center of the length at an angle of 90°. Then, the line connecting the both ends of the first strip line resonator 2 and the line connecting the both ends of the third strip line resonator 4 are disposed in parallel, and the bent directions thereof are oriented in the directions opposite to each other.

[0016] The linear second strip line resonator 3 is disposed between the first strip line resonator 2 and the third strip line resonator 4. A linear part 3a, one side from the center position of the length to one end, faces a linear part 2a in parallel, one side of the bent first strip line resonator 2, and a linear part 3b, the other side from the center position to the other end, faces a linear part 4a in parallel, one side of the bent third strip line resonator 4. Therefore, the three strip line resonators 2 to 4 are disposed almost linearly as a whole.

[0017] The first transmission line 6 is bent in an elbow shape, and a linear part 6a, one side thereof, faces a linear part 2b in parallel, the other side of the first strip line resonator 2. Moreover, the second transmission line 7 is also bent in an elbow shape, and a linear part 7a, one side thereof, faces a linear part 4b in parallel, the other of the third strip line resonator 4. Then, signals are inputted to a linear part 6b, the other of the first transmission line 6, or a linear part 7b, the other of the second transmission line 7, and the signals transmitted through each of the strip line resonators 2 to 4 are outputted from the other.

[0018] In the configuration, electromagnetic coupling between two lines having the alternate relationship is weakened including the transmission lines 6 and 7 for inputting and outputting signals. For example, in the relationship between the first transmission line 6 and the second strip line resonator 3, the linear part 6a, one side of the first transmission line 6, and the second strip line resonator 3 are perpendicular to each other in the linear directions thereof. Therefore, the electromagnetic coupling is weakened. It is the same in the relationship between the second strip line resonator 3 and the second transmission line 7.

[0019] Additionally, in the relationship between the first strip line resonator 2 and the third strip line resonator 4, the linear part 2a, one side of the first strip line resonator 2, and the linear part 4a, the other side of the third strip line resonator 4, are in parallel with each other. However, since there are no portions facing each other in the linear directions thereof, the electromagnetic coupling to each other is weakened.

[0020] Consequently, in the transmission characteristics, the attenuation on the low pass side of the passband is reduced, and the whole passband has nearly flat characteristics as shown in Fig. 3.

[0021] Fig. 4 depicts an embodiment that all of strip line resonators are bent, having the configuration in which the second strip line resonator 3 in Fig. 2 is bent at an angle of about 90° in the center part thereof. In this case, in the relationship between a first strip line resonator 2 and a third strip line resonator 4, a linear part 2a, one side of the first strip line resonator 2 and a linear part 4a, one side of the third strip line resonator 4, are perpendicular to each other in the linear directions thereof. Therefore, the electromagnetic coupling is weakened. Accordingly, the transmission characteristics as shown in Fig. 3 are shown in Fig. 4 as well.

[0022] Furthermore, the bent angle of the strip line resonators is desirably at an angle of 90°, but it is not necessarily defined at an angle of 90°.

Claims

1. A bandpass filter **characterized by** comprising:

a dielectric substrate;
a plurality of strip line resonators formed on the dielectric substrate as electromagnetically coupled to each other with both ends opened; and
two transmission lines formed on the dielectric substrate for connecting external circuits,

wherein at least one or more of the strip line resonators is bent at a center part in a length direction.

2. The bandpass filter according to claim 1, **characterized in that** at least two or more of the strip line resonators are bent, and lines connecting the both ends of the bent strip lines are in parallel with each other.

3. The bandpass filter according to claim 1 or 2, **characterized in that** the bent angle is an angle of about 90°.

FIG. 1

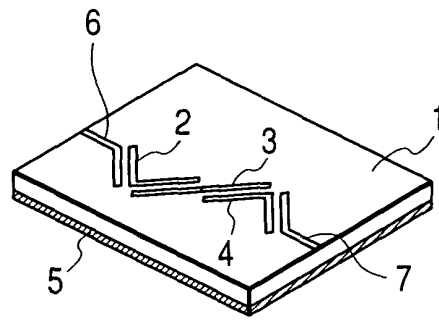


FIG. 2

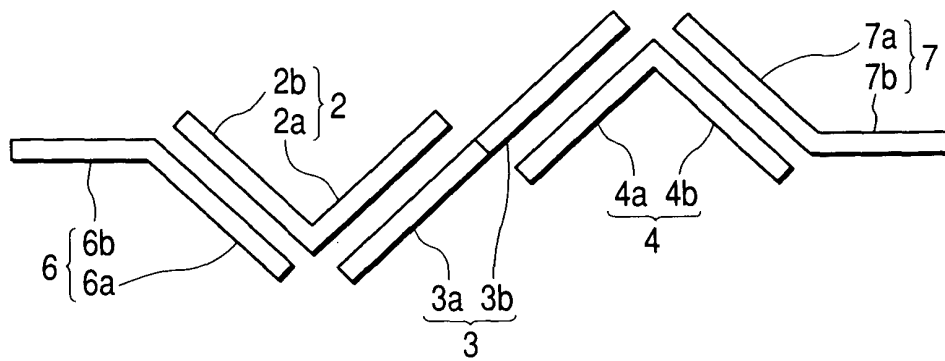


FIG. 3

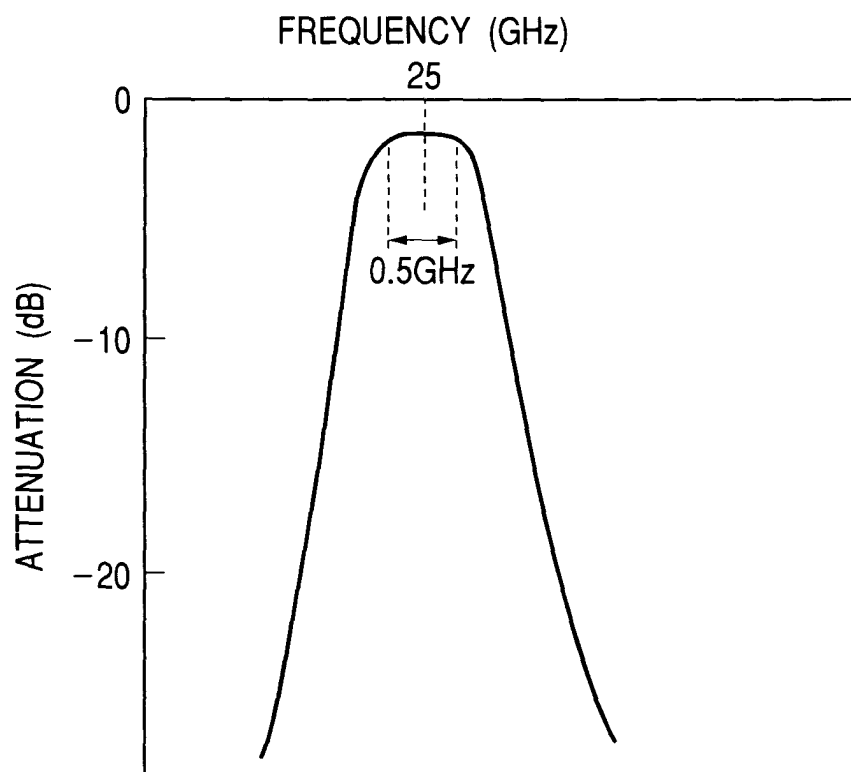


FIG. 4

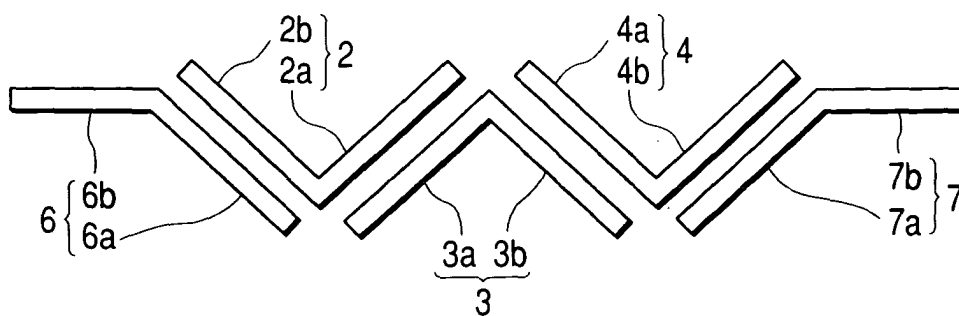


FIG. 5
PRIOR ART

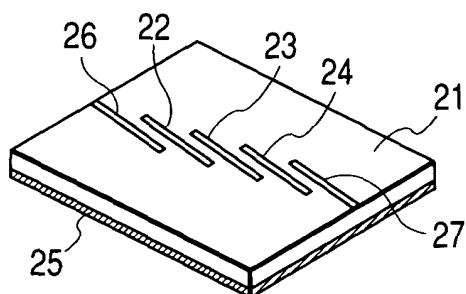
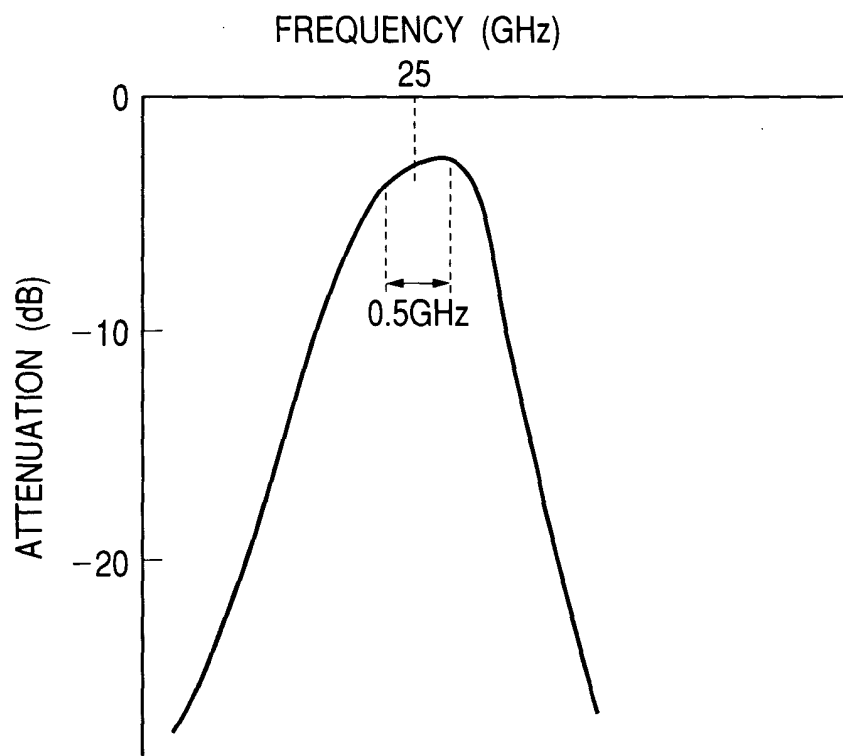


FIG. 6
PRIOR ART





European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 03 25 5570

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 14 January 2004	Examiner Den Otter, A
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

EPO FORM 1503 03.82 (P04001)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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