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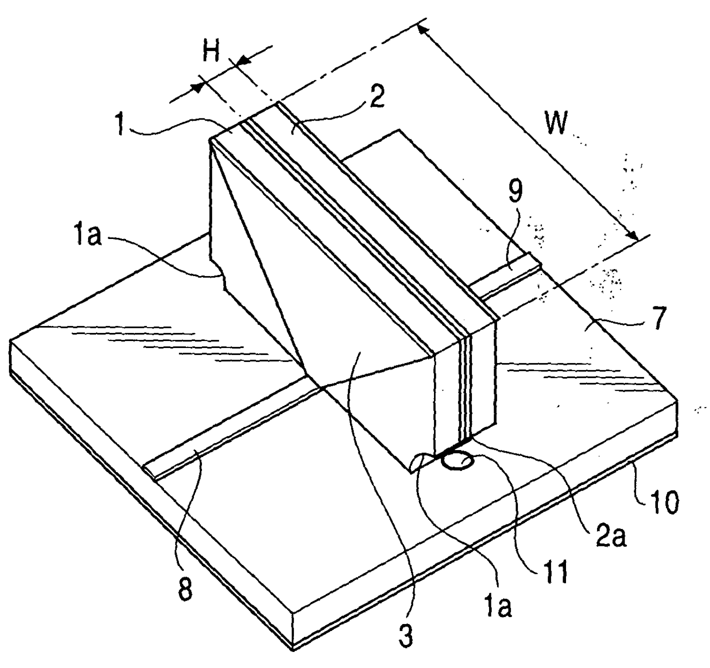
(54) Band-pass filter

(57) A band-pass filter includes first and second substrates, each having a triangular microstrip conductor on one surface and a grounding conductor on the other surface, and a third substrate having first and second conductive lines on one surface and a grounding conductor on the other surface. The first and the second substrates are joined at their surfaces having the grounding conductors, and the joined substrates are disposed on one surface of the third substrate such that one side of each of the microstrip conductors is parallel to the surface of the third substrate. The apex of one microstrip conductor is connected to the first conductive line, the apex of the other microstrip conductor is connected to the second conductive line, and the grounding conductors on the first and second substrates are connected to the grounding conductor on the third substrate.

FIG. 1



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a band-pass filter having microstrip conductors, and particularly to a band-pass filter having triangular microstrip conductors.

2. Description of the Related Art

[0002] Nowadays, band-pass filters having triangular microstrip conductors (sometimes called cymbal band-pass filters) are being studied.

[0003] Fig. 6 shows a conventional cymbal band-pass filter, which includes a substrate 31 having two triangular microstrip conductors 32 and 33 formed on the upper surface thereof. The first microstrip conductor 32 and the second microstrip conductor 33 are shaped like isosceles triangles of the same size, and are disposed so that corresponding sides (bases) of the two microstrip conductors 32 and 33 are parallel to each other. The distance between the parallel bases and the sizes of the microstrip conductors determine characteristics such as the band-pass center frequency, bandwidth, loss, and skirt characteristics. In order to achieve a band-pass center frequency of 25 GHz, for example, the length W of each base is about 4.77 mm, the distance G (not shown in Fig. 6) between the bases is 0.15 mm, and the height K from each base to the opposite apex is 0.6 mm. The thickness H of the substrate 31 is 0.25 mm.

[0004] Referring again to Fig. 6, the substrate 31 has a first conductive line 34 and a second conductive line 35. The first conductive line 34 is connected to the apex opposite to the base of the first microstrip conductor 32. The second conductive line 35 is connected to the apex opposite to the base of the second microstrip conductor 33. The substrate 31 further includes a grounding conductor (not shown in Fig. 6) formed on its rear surface. The conductive lines 34 and 35 have a characteristic impedance of, for example, 50 ohm. One of the conductive lines 34 and 35 is used for signal input and the other for signal output. Useful information about these band-pass filters can be found in non-patent document, IEEE TRANSACTIONS ON MICROWAVE THEORY AND TECHNIQUES, VOL. 50. NO. 5, MAY 2002, P. 1431-1432, for example.

[0005] In the band-pass filter described above, the apexes opposite to the bases of the two triangular microstrip conductors function as the input and output terminals of the band-pass filter, where the distance between the input and output terminals is about 1.35 mm. This size of about 1.35 mm is not satisfactory to meet recent demands for more compact high-frequency devices. Unfortunately, reducing the size of microstrip conductors causes another problem with the performance of the band-pass filter.

SUMMARY OF THE INVENTION

[0006] Accordingly, an object of the present invention is to provide a compact band-pass filter while still maintaining high electrical performance.

[0007] In order to achieve the object described above, a band-pass filter according to an aspect of the present invention includes a first substrate having a first triangular microstrip conductor formed on a first surface thereof and a first grounding conductor formed on a second surface thereof; a second substrate having a second triangular microstrip conductor formed on a first surface thereof and a second grounding conductor formed on a second surface thereof; and a third substrate having a first conductive line and a second conductive line formed on a first surface thereof and a third grounding conductor formed on a second surface thereof. The first substrate and the second substrate are joined at the second surfaces, and are disposed on the first surface of the third substrate such that a first side of each of the first and second microstrip conductors is parallel to the first surface of the third substrate. Furthermore, the apex opposite to the first side of the first microstrip conductor is connected to the first conductive line, the apex opposite to the first side of the second microstrip conductor is connected to the second conductive line, and the first and second grounding conductors are connected to the third grounding conductor.

[0008] In the band-pass filter described above, the distance between the apexes of the microstrip conductors, i.e., the input and output terminals of the band-pass filter can be reduced dramatically, thus contributing to compact design of the band-pass filter.

[0009] The band-pass filter may include a fourth substrate disposed on the top side of each of the first and second substrates, that is, the top side along the first side of each of the first and second microstrip conductors; and a coupling conductor disposed on the fourth substrate to couple the first and second microstrip conductors with each other.

[0010] In the band-pass filter described above, the two microstrip conductors are made electrically closer to each other via the coupling conductor, and therefore, are coupled with each other more strongly.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011]

Fig. 1 is a perspective view of a band-pass filter according to a first embodiment of the present invention;

Fig. 2 is a front view of the band-pass filter according to the first embodiment of the present invention;

Fig. 3 is a side view of the band-pass filter according to the first embodiment of the present invention;

Fig. 4 is a perspective view of a band-pass filter according to a second embodiment of the present invention;

Fig. 5 is a side view of the band-pass filter according to the second embodiment of the present invention; and

Fig. 6 is a perspective view of a conventional band-pass filter.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0012] Band-pass filters according to embodiments of the present invention are illustrated in Figs. 1 to 5. Fig. 1 is a perspective view of a band-pass filter according to a first embodiment. Fig. 2 is a front view of the band-pass filter. Fig. 3 is a side view of the band-pass filter. Fig. 4 is a perspective view of a band-pass filter according to a second embodiment. Fig. 5 is a side view of the band-pass filter shown in Fig. 4.

[0013] Referring to Figs. 1 to 3, the band-pass filter according to the first embodiment of the present invention includes two rectangular substrates of the same size, a first substrate 1 and a second substrate 2, each having a thickness H of 0.25 mm. The band-pass filter further includes a third substrate 7.

[0014] The first substrate 1 includes a first triangular microstrip conductor 3 formed on one surface thereof and a grounding conductor 4 formed on the other entire surface thereof.

[0015] The second substrate 2 includes a second triangular microstrip conductor 5 formed on one surface thereof and a grounding conductor 6 formed on the other entire surface thereof. The first microstrip conductor 3 and the second microstrip conductor 5 are of the same size.

[0016] The third substrate 7 includes a first conductive line 8 and a second conductive line 9 on its upper surface and a grounding conductor 10 on its entire lower surface.

[0017] The first substrate 1 and the second substrate 2 are jointed at the surfaces having the respective grounding conductors 4 and 6 so that the two grounding conductors 4 and 6 are in contact with each other. The main surfaces of each of the first substrate 1 and the second substrate 2 have a side with a length substantially equal to the length W of one side (base) of the corresponding microstrip conductor, and another perpendicular side with a length substantially equal to the height K from the base to the opposite apex of the corresponding microstrip conductor. The length W and the height K are about 4.77 mm and about 0.6 mm, respectively, to achieve a band-pass center frequency of 25 GHz.

[0018] The two substrates 1 and 2 thus joined are secured to the upper surface of the third substrate 7 by bonding means such as an adhesive (not shown in Figs. 1 to 3) so that the bases of the microstrip conductors 3 and 5 are distant from and parallel to the upper surface of the third substrate 7 and the apexes of the microstrip conductors 3 and 5 face down. This arrangement brings the apexes of the microstrip conductors 3 and 5 into contact with the upper surface of the third substrate 7. The two apexes function as the input and output terminals of the band-pass filter.

[0019] Each of the first substrate 1 and the second substrate 2 further includes two notches, one at each corner on the left and right edges of the surface in contact with the upper surface of the third substrate 7. The notches on the first substrate 1 and the second substrate 2 are denoted by 1a and 2a, respectively.

[0020] The conductive lines 8 and 9 formed on the upper surface of the substrate 7 have a characteristic impedance of, for example, 50 ohm. One of the conductive lines 8 and 9 is used for signal input and the other for signal output. The apex opposite to the base of the first microstrip conductor 3 is connected to the first conductive line 8 and the apex opposite to the base of the second microstrip conductor 5 is connected to the second conductive line 9 by bonding means such as soldering.

[0021] The third substrate 7 further includes two through-holes. 11, adjacent to the notches 1a and 2a. Each of the through-holes 11 has, on its inner wall, an inner conductor 11a connected to the grounding conductor 10. The grounding conductors 4 and 6 exposed at the notches 1a and 2a are connected to the inner conductors 11a in the through-holes 11. As a result, the grounding conductor 4 of the first substrate 1 and the grounding conductor 6 of the second substrate 2 are electrically conductive with the grounding conductor 10 of the third substrate 7.

[0022] According to the structure described above, the first microstrip conductor 3 and the second microstrip conductor 5 are coupled with each other around their bases to exhibit predetermined characteristics.

[0023] The distance between the apexes opposite to the bases of the two microstrip conductors, i.e., input and output terminals of the band-pass filter, is about 0.51 mm, which is about one-third of that for a conventional band-pass filter. Thus, the band-pass filter according to the first embodiment is compact.

[0024] The two substrates 1 and 2 are covered with a shielding case, which is not shown in Figs. 1 to 3.

[0025] A fourth substrate 21 may be provided in order to more strongly couple the first microstrip conductor 3 with the second microstrip conductor 5. Referring to Figs. 4 and 5 showing a band-pass filter according to a second embodiment, the fourth substrate 21 is disposed on the top sides of the first substrate 1 and the second substrate 2 such that the fourth substrate 21 extends along the bases of the microstrip conductors 3 and 5. Furthermore, the fourth substrate 21 has a coupling conductor 22 on its upper surface. Thus, the two microstrip conductors 3 and 5 are made electrically closer to each other via the coupling conductor 22, and are therefore coupled with each other more strongly. The thickness of the fourth substrate 21 and the width of the coupling conductor 22 affect the strength of coupling between the two microstrip conductors 3 and 5, and hence need to be determined appropriately.

Claims

1. A band-pass filter comprising:

a first substrate including:

a first triangular microstrip conductor formed on a first surface thereof; and
a first grounding conductor formed on a second surface thereof;

a second substrate including:

a second triangular microstrip conductor formed on a first surface thereof; and
a second grounding conductor formed on a second surface thereof; and

a third substrate including:

a first conductive line and a second conductive line formed on a first surface thereof; and
a third grounding conductor formed on a second surface thereof,

wherein the first substrate and the second substrate are joined at the second surfaces, and are disposed on the first surface of the third substrate such that a first side of each of the first and second microstrip conductors is parallel to the first surface of the third substrate; and

wherein the apex opposite to the first side of the first microstrip conductor is connected to the first conductive line, the apex opposite to the first side of the second microstrip conductor is connected to the second conductive line, and the first and second grounding conductors are connected to the third grounding conductor.

2. The band-pass filter according to claim 1, further comprising:

a fourth substrate disposed on the top side of each of the first and second substrates, the top side being along the first side of each of the first and second microstrip conductors; and
a coupling conductor disposed on the fourth substrate to couple the first and second microstrip conductors with each other.

FIG. 1

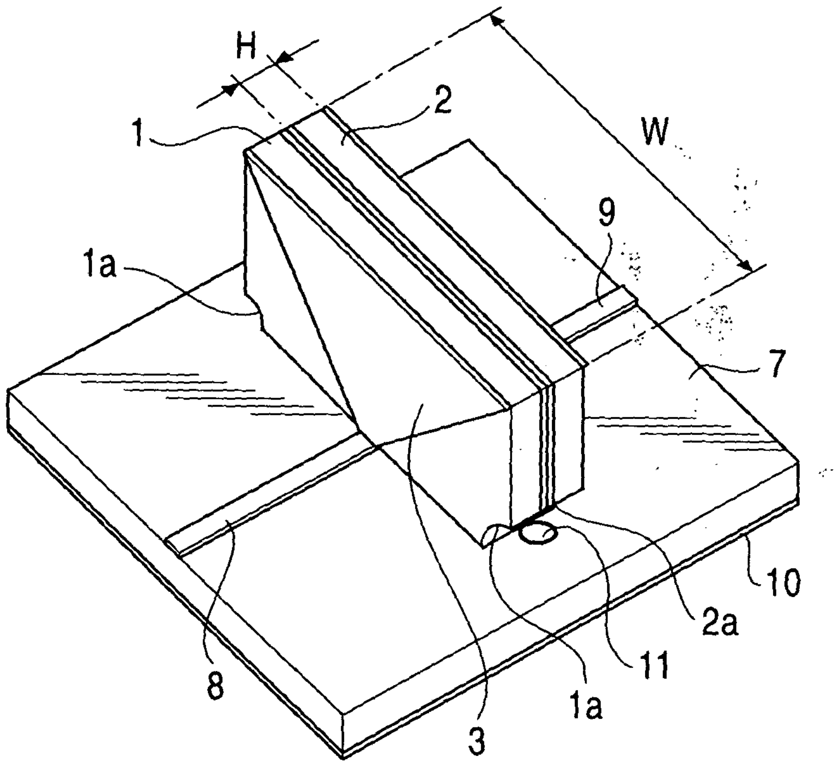


FIG. 2

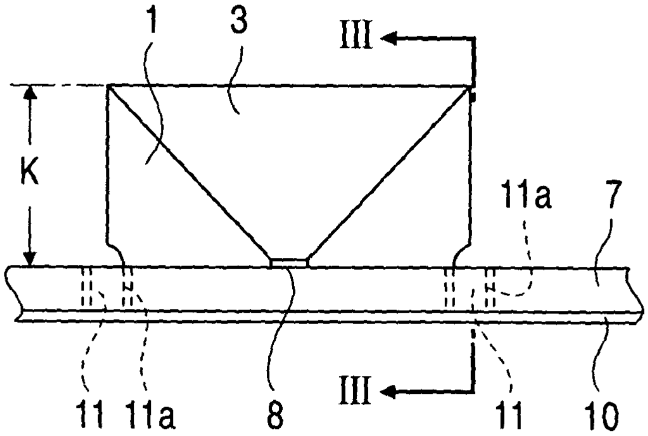


FIG. 3

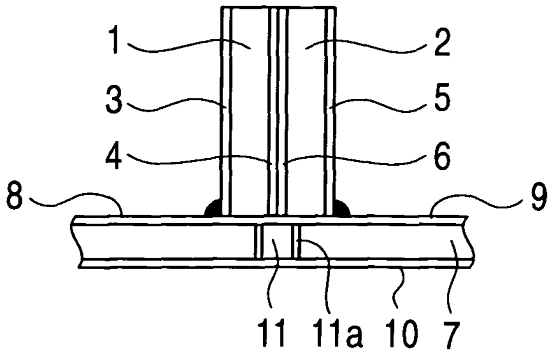


FIG. 4

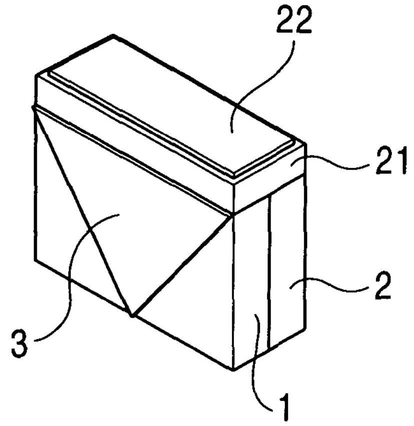


FIG. 5

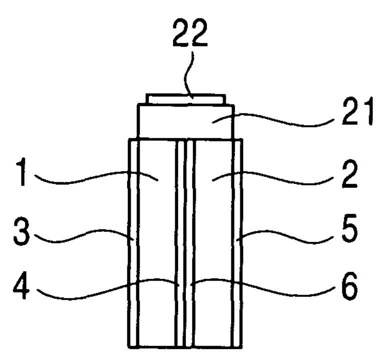
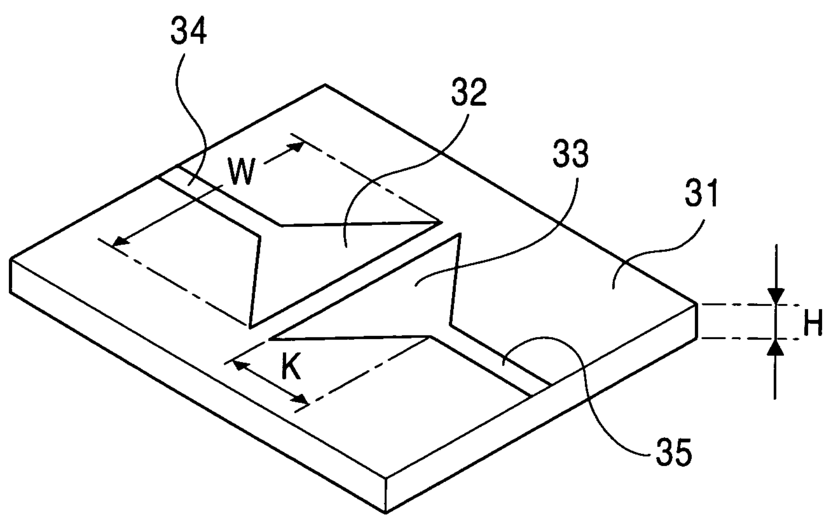


FIG. 6
PRIOR ART



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EUROPEAN SEARCH REPORT

Application Number
EP 03 25 5936

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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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A	US 4 757 286 A (KONISHI YOSHIHIRO ET AL) 12 July 1988 (1988-07-12) * column 5, line 4 - column 6, line 17; figures 6A-D * ---	1	
A	US 4 758 805 A (SAKURAI TAKASHI ET AL) 19 July 1988 (1988-07-19) * column 4, line 52 - column 5, line 5; figure 7 * ---	1	
A	PATENT ABSTRACTS OF JAPAN vol. 011, no. 033 (E-476), 30 January 1987 (1987-01-30) -& JP 61 201501 A (MITSUBISHI ELECTRIC CORP), 6 September 1986 (1986-09-06) * abstract; figures 1,2 * ---	1	TECHNICAL FIELDS SEARCHED (Int.Cl.7): H01P
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	7 January 2004	Den Otter, A

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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