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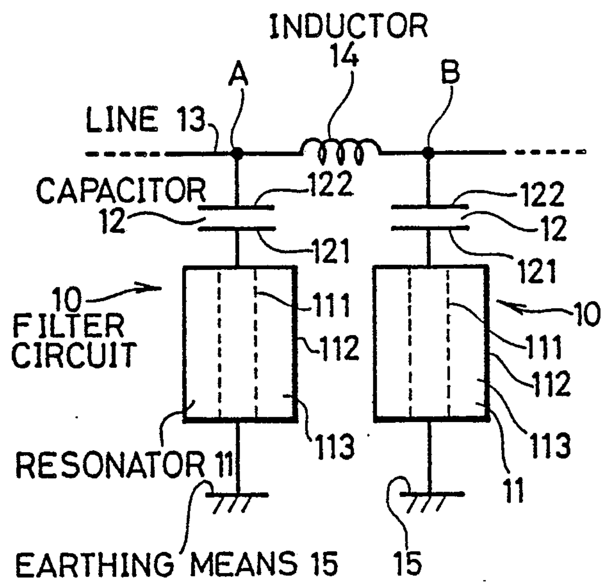
(54) Band elimination filter.

(57) A band elimination filter includes a filter circuit (10) which is formed by a dielectric resonator (11) exhibiting inductiveness at a frequency f_2 and a capacitor (12) connected in series with the dielectric resonator, and an input/output transmission line (13) which has an inductor (14) connected to the capacitor (12) of the filter circuit (10). Only the aforementioned filter circuit (10) is connected between an end portion of the inductor (14) and earthing means. In the band elimination filter having such structure, a signal attenuation amount is abruptly changed around the trap frequency f_2, to improve the passing characteristic.

FIG.1



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Band Elimination Filter

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a band elimination filter, and more particularly, it relates to a band elimination filter utilizing resonators such as dielectric resonators.

Description of the Background Art

Fig. 10 shows exemplary structure of a conventional band elimination filter which is disclosed in Japanese Patent Laying-Open Gazette No. 193501/1986, for example.

Referring to Fig. 10, dielectric resonators 1 are connected in series with capacitors 2. A transmission line 3 has an inductor 4. On respective ends of the inductor 4, the capacitors 2 and the resonators 1 are connected between the transmission line 3 and earthing means 15, while other capacitors 5 are connected in parallel with the same.

The band elimination filter shown in Fig. 10 generally exhibits frequency-signal attenuation characteristics shown in Fig. 11, assuming that f_2 represents a trap frequency.

The aforementioned conventional band elimination filter requires the capacitors 5 which are directly connected to the earthing means, in addition to the capacitors 2 for attaining filter characteristics. Thus, the filter structure is inevitably complicated.

Further, the aforementioned conventional band elimination filter cannot be regarded as having excellent filter characteristics, since the signal attenuation amount is gradually reduced from the trap frequency f_2 toward zero.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a band elimination filter, the filter structure of which is simplified to reduce the manufacturing cost as well as to improve mass productivity.

Another object of the present invention is to provide a band elimination filter which can improve filter characteristics.

A band elimination filter according to the present invention includes a filter circuit and an input/output transmission line having inductance means. The aforementioned filter circuit has a resonator and capacitance means which is connected in series with the resonator. Only the aforementioned filter circuit is connected between each end of the aforementioned inductance means and earthing means.

The band elimination filter according to the present invention requires no capacitor, which has generally been directly connected between the transmission line and the earthing means in the prior art. Consequently, the filter structure is simplified to reduce the manufacturing cost and to improve mass productivity.

According to the inventive band elimination filter, change in signal attenuation amount is abruptly inclined around a trap frequency, thereby to enable implementation of excellent filter characteristics as the result.

These and other objects, features, aspects and advantages of the present invention will become more apparent from the following detailed description of the present invention when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a circuit diagram showing an embodiment of the present invention;

Figs. 2, 3 and 4 are equivalent circuit diagrams of the circuit shown in Fig. 1 as viewed from different points;

Fig. 5 is a graph showing frequency-admittance characteristics;

Fig. 6 is a graph showing frequency-signal attenuation amount characteristics;

Figs. 7 and 8 are partially fragmented plan views showing other embodiments of the present invention;

Fig. 9 is a partially fragmented perspective view showing a further embodiment of the present invention;

Fig. 10 is a circuit diagram showing a conventional filter in correspondence to Fig. 1; and

Fig. 11 is a graph showing the characteristics of the conventional filter in correspondence to Fig. 6.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1 shows an embodiment of a band elimination filter according to the present invention.

Referring to Fig. 1, filter circuits 10 are formed by dielectric resonators 11, which are examples of resonators exhibiting inductiveness at a frequency f_2, and capacitors 12 which are connected in series with the resonators 11. The dielectric resonators 11 are formed by internal conductors 111, external conductors 112 and dielectric members 113 of TiO_2-ZrO_2-SnO_2 ceramic dielectric material etc. which are disposed between the internal and external conductors 111 and 112. The internal conductors 111 are electrically connected to first electrodes 121 of the capacitors 12.

On the other hand, an input/output transmission line 13 has an inductor 14. Second electrodes 122 of the capacitors 12 of the filter circuits 10 are connected to respective ends (points A and B) of the inductor 14. The external conductors 112 of the resonators 11 of the filter circuits 10 are connected to earthing means 15.

In the band elimination filter shown in Fig. 1, no conventional capacitors (capacitors 5 in Fig. 10) are connected to the points A and B. Considering a given frequency f_1, therefore, it can be regarded that antiresonance is caused to develop opening states in the points A and B at the frequency f_1. With reference to the points A and B, it can be regarded that LC parallel circuits 16 are formed as shown in Fig. 2, to be in resonant states. Referring to Fig. 2, capacitors 17 of the LC parallel circuits 16 and the inductor 14 can be regarded as π-type distributed constant lines.

Thus, the band elimination filter according to this embodiment can be regarded as comprising a circuit in which a distribution constant line 18 is arranged between the points A and B while inductors 19 are arranged between the points A and B and earthing means, as shown in Fig. 3. Considering each resonator 11 of the circuit shown in Fig. 3 as an LC parallel circuit, an equivalent circuit thereof is as shown in Fig. 4. Referring to Fig. 4, a capacitor 20 and an inductor 21, which are connected in parallel with each other, are arranged between the capacitor 12 and the earthing means 15. Admittance Y between the point A and the earthing means 15 is obtained as follows:

$$Y = \{\omega^4 L_1 L_0 C_1 C_0 - \omega^2(L_0 C_0 + L_1 C_1 + L_0 C_1) + 1\}/j\omega L_1(1 - \omega^2 L_0 C_0 - \omega^2 L_0 C_1)$$

where L_0 represents inductance of the inductor 21, L_1 represents inductance of the inductor 19, C_0 represents capacitance of the capacitor 20, and C_1 represents capacitance of the capacitor 12 respectively. Assuming that f_1 represents an antiresonance frequency and f_2 represents a trap frequency, the admittance Y is zero at the antiresonance frequency f_1, while the admittance Y is infinite at the trap frequency f_2. Fig. 5 shows the relation between the frequency and the admittance in this case. Regarding this as the passing characteristic of the transmission line, the relation between the frequency and the signal attenuation amount is as shown in Fig. 6. As understood from Fig. 6, the signal attenuation amount is nearly zero at the antiresonance frequency f_1. Therefore, as obvious from comparison with Fig. 11 showing the characteristics of the conventional band elimination filter, the signal attenuation amount is more abruptly changed around the trap frequency f_2 according to this embodiment. In other words, the passing characteristic is improved in a frequency domain below the trap frequency f_2. Utilizing the frequency f_1 as a passing band, on the other hand, insertion loss is reduced.

Concrete structure of the band elimination filter according to this embodiment is now described.

For example, the structure shown in Fig. 7 is employable. Referring to Fig. 7, a plurality of capacitor electrodes 31 and 32 are provided on an upper surface of a substrate 30. Inductor electrodes 33, which are integrally formed with the capacitor electrodes 31, are arranged between the capacitor electrodes 31. Central conductors 35 provided in opening ends 341 of resonators 34 are connected to the capacitor electrodes 32. Electrostatic capacitance is implemented by the capacitor electrodes 31 and 32.

In place of the aforementioned inductor electrodes 33, inductors 36 may be connected between capacitor electrodes 31 which are adjacent to each other, as shown in Fig. 8.

Alternatively, disc-type capacitors 37 may be connected to opening ends 341 of resonators 34 while connecting a transmission line 39 having an inductor 38 to electrodes of the capacitors 37 as shown in Fig. 9, without employing the substrate 30 etc.

Further, such capacitors 37 may be replaced by terminals which are inserted in bushing members of synthetic resin while leaving parts of metal pins, to implement electrostatic capacitance between the metal pins and internal conductors of resonators.

In addition, the dielectric resonators may be replaced by LC resonators or stripline resonators.

Although the present invention has been described and illustrated in detail, it is clearly understood that the same is by way of illustration and example only and is not to be taken by way of limitation, the spirit and scope of the present invention being limited only by the terms of the appended claims.

Claims

1. A band elimination filter including:
a filter circuit (10) formed by a resonator (11, 34) and capacitance means (12, 31, 32) connected in series with said resonator (11, 34);
inductance means (14, 33, 36, 38) having an end portion;
an input/output transmission line (13, 39) connected

to said end portion of said inductance means (14, 33, 36, 38); and
earthing means (15),
only said filter circuit (10) being connected between said end portion of said inductance means (14, 33, 36, 38) and said earthing means (15).

2. A band elimination filter in accordance with claim 1, wherein
said band elimination filter has a trap frequency (f_2),
a signal attenuation amount being abruptly changed at said trap frequency (f_2).

3. A band elimination filter in accordance with claim 2, wherein
said band elimination filter has an antiresonance frequency(f_1),
a signal attenuation amount is small at said antiresonance frequency(f_1).

4. A band elimination filter in accordance with claim 1, wherein
said resonator (11, 34) has an opening end (341),
said capacitance means is a disc-type capacitor (37) which is connected to said opening end (341), and
said inductance means is an inductor (38) which is connected to said capacitor (37).

5. A band elimination filter in accordance with claim 1, wherein
said resonator (11, 34) is a dielectric resonator (11, 34).

6. A band elimination filter including:
a resonator (34) having an opening end (341) and a central conductor (35); and
a substrate (30) being provided in the vicinity of said opening end (341) of said resonator (34),
said substrate (30) essentially comprising a first capacitor electrode4 (32) being electrically connected to said central conductor (35), a second capacitor (31) being paired with said first capacitor electrode (32) and inductor means (33, 36) being electrically connected to said second capacitor electrode (31).

7. A band elimination filter in accordance with claim 6, wherein
said inductor means is an inductor electrode (33) which is integrally formed with said capacitor electrode (31).

8. A band stop filter for use with a signal carrying line having a series inductance (14), the band stop filter comprising a capacitor (12) in series with a dieletric resonator (11) and being characterised in that only the capacitor (12) and the resonator (11) create a path from the line to earth for signals in the frequency stop band.

FIG.1

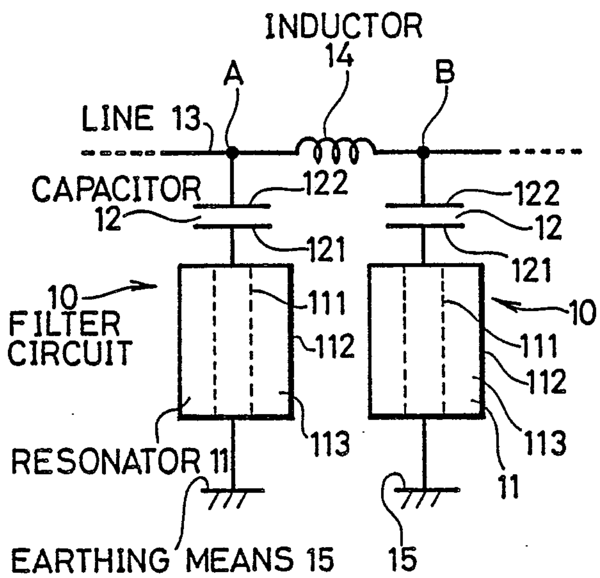

FIG.2

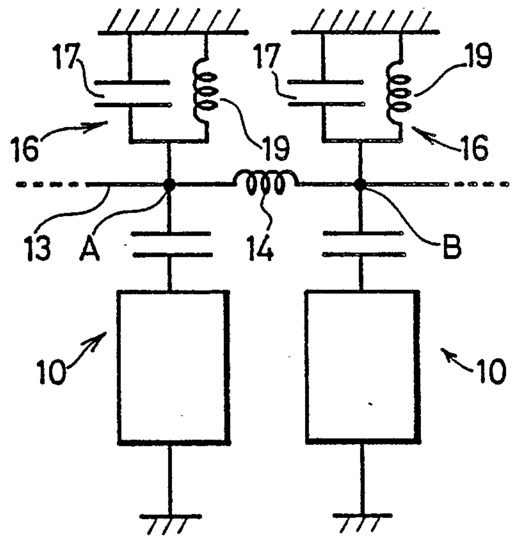

FIG.3

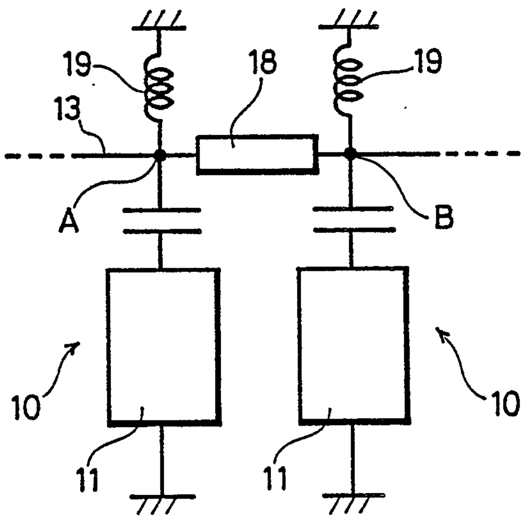

FIG.4

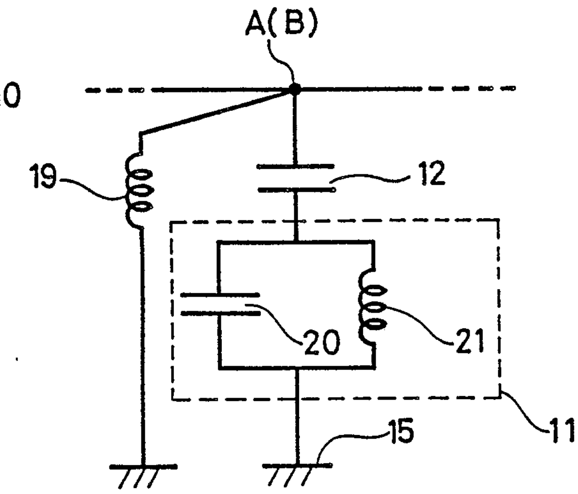

FIG.5

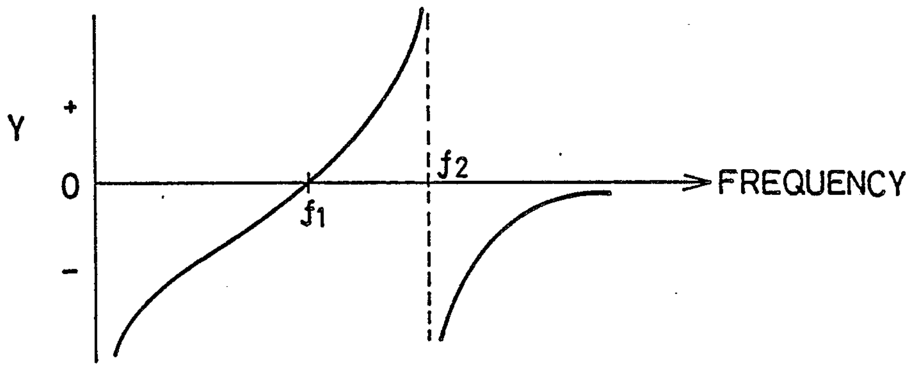

FIG.6

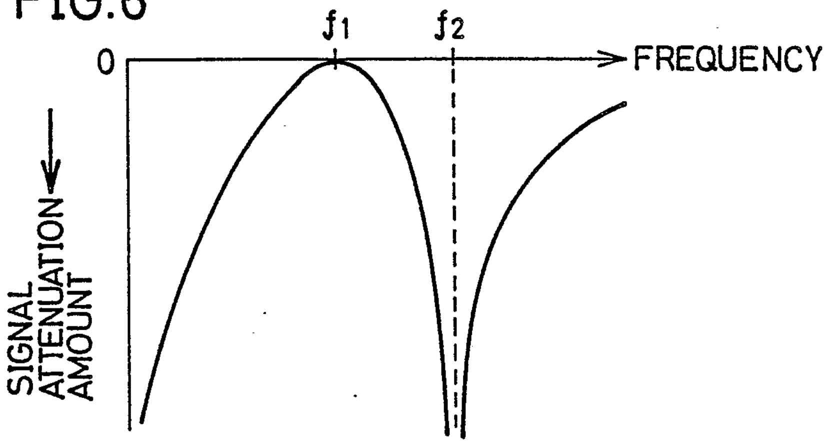

FIG.11 BACKGROUND ART

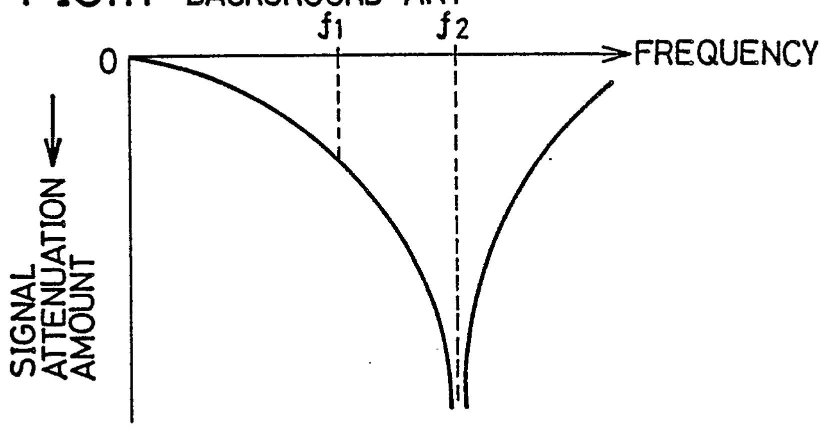

FIG.7

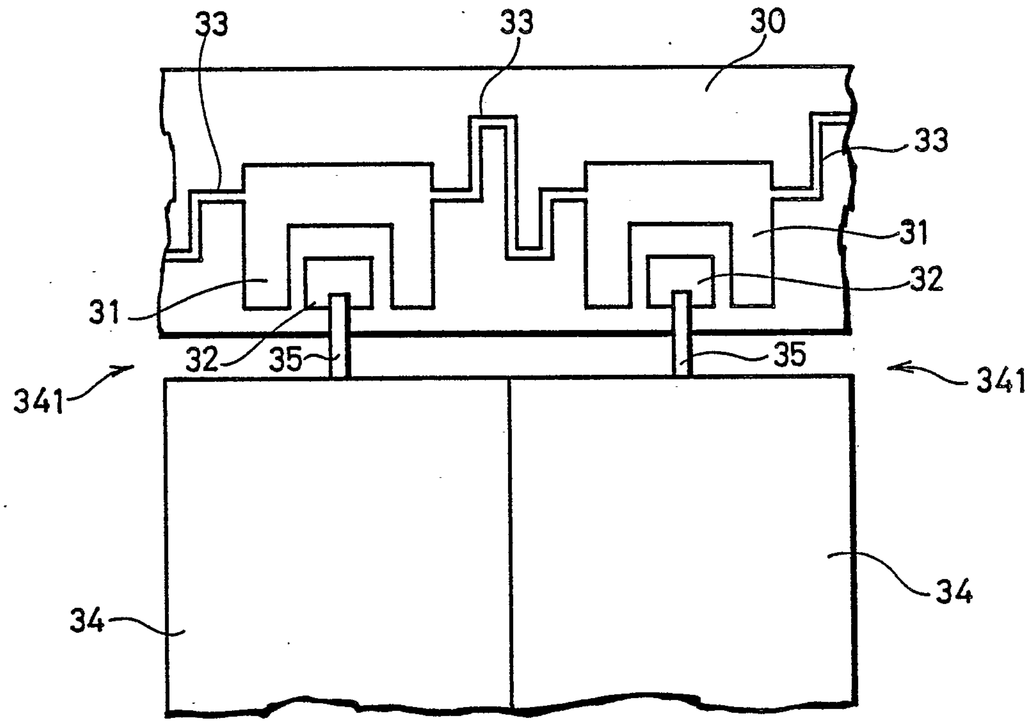

FIG.8

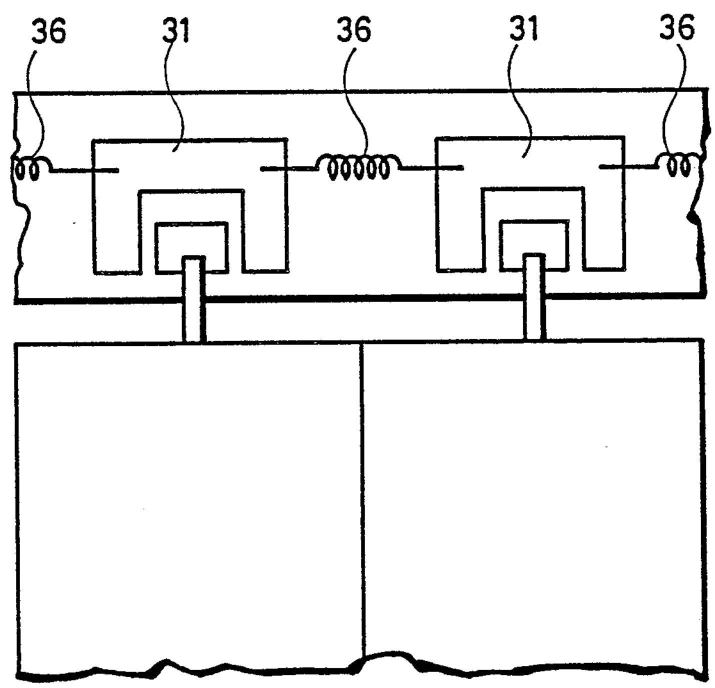

FIG.9

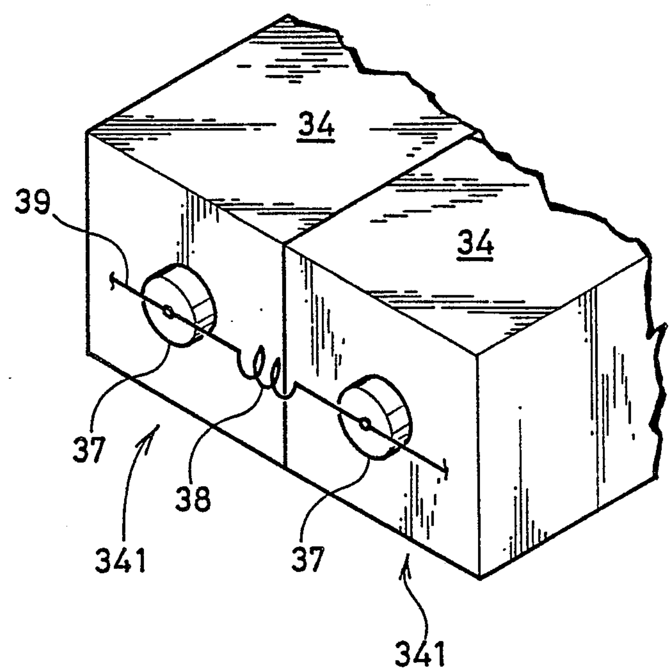

FIG.10 BACKGROUND ART