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(54) High-frequency component

(57) A high-frequency component is provided that can easily realize a higher characterisitic impedance of a transmission line which constitutes an inductance element, that can be formed into a smaller size, and that has excellent frequency characteristics. In the high-frequency component, a high-pass filter (F1) formed of a transmission line (L1) and three capacitors (C1 - C3) is connected between a first port (P1) and a second port P2), and a low-pass filter (F2) formed of another transmission line (L2), which is an inductance element, and two capacitors (C4, C5), which are capacitance elements, is connected between the first port (P1) and the third port (P3).

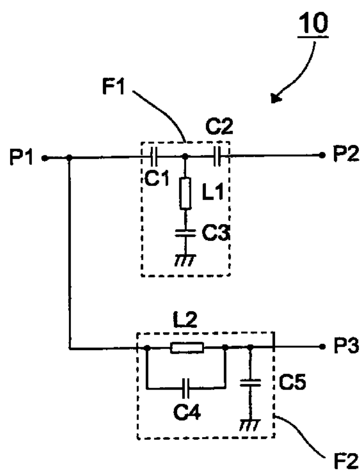

FIG.1

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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a high-frequency component that distributes and couples a high-frequency signal of two different frequency regions in a high-frequency circuit of a mobile communication apparatus, such as, a portable telephone.

2. Description of the Related Art

[0002] Fig. 6 shows a see-through perspective view of a duplexer, which is an example of a high-frequency component that distributes and couples a high-frequency signal. Although not shown, the duplexer 50 is formed in such a way that a high-pass filter (HPF) and a low-pass filter (LPF) are contained in the same multilayer board 50a. External terminals Ta to Tc are provided from a position near one of the long sides of the bottom surface of the multilayer board 50a to the side surface nearest to this long side. Also, external terminals Td to Tf are provided from a position near the other long side of the rear surface of the multilayer board 50a to the side surface nearest to the other long side.

[0003] Figs. 7A, 7B, 7C, 7D, 7E, and 7F, and Fig. 8A show top plan views of each dielectric layer which is a constituent of the duplexer 50 of Fig. 6, and Fig. 8B shows a bottom plan view thereof. The duplexer 50 is formed in such a way that first to ninth multiple dielectric layers 51 to 59 are layered in sequence from the top.

[0004] Capacitor electrodes C51 and C52 are provided on the top surface of the second dielectric layer 52; capacitor electrodes C53, C54, and C55 are provided on the top surface of the third dielectric layer 53; capacitor electrodes C56, C57, and C58 are provided on the top surface of the fourth dielectric layer 54; and capacitor electrodes C59 and C60 are provided on the top surface of the eighth dielectric layer 58. Also, both transmission lines L51 and L52 are provided on the top surface of the fifth dielectric layer 55.

[0005] Furthermore, grounding electrodes G51 and G52 are provided on the top surfaces of the seventh and ninth dielectric layers 57 and 59, respectively. Also, external terminals Ta to Tf are provided on the bottom surface (Fig. 8B) of the ninth dielectric layer 59.

[0006] In the second to seventh dielectric layers 52 to 57, viaholes VHb' to VHg' are provided at predetermined positions, respectively.

[0007] The capacitor electrodes C51, C53, and C56, the capacitor electrodes C52, C54, and C57, and the capacitor electrode C59 and grounding electrodes G51 and G52 provides three capacitors which are constituents of a HPF, and capacitor electrodes C55 and C58 and capacitor electrode C60, and grounding electrodes G51 and G52 provide two capacitors which are constituents of an LPF. Also, a transmission line L51 forms an inductance element which is a constituent of an HPF, and a transmission line L52 forms an inductance element which is a constituent of the LPF. With such a construction, the high-frequency component 50 is provided in one multilayer board 50a.

[0008] However, in the duplexer, which is a conventional high-frequency component, since transmission lines which constitute the inductance elements of the HPF and LPF are provided on one dielectric layer, and the length of the transmission line per, layer is increased, presenting the problem that the size of the high-frequency component (duplexer) is enlarged.

[0009] Also, in order to shut off the transmission line from electromagnetic noise from an outside source, a transmission line is disposed between two grounding electrodes. However, because of the influence of stray capacitance generated between the transmission line and the grounding electrode, the characteristic impedance of the transmission line is decreased. Therefore, the insertion loss of the high-frequency component in which this transmission line is used as an inductance element is increased, resulting in a problem that the band width of the high-frequency component becomes narrower.

[0010] Furthermore, in order to achieve a higher characteristic impedance of the transmission line, there is a method for increasing the spacing between the transmission line and the grounding electrode. In this case, however, there is a problem in that it is difficult to reduce the size of the high-frequency component.

SUMMARY OF THE INVENTION

[0011] An object of the present invention, the achievement of which will solve such problems, is to provide a high-frequency component that can easily realize a higher characteristic impedance of a transmission line which constitutes an inductance element, that can be formed into a smaller size, and that has excellent frequency characteristics.

[0012] To achieve the above-mentioned object, according to the present invention, there is provided a high-frequency component, comprising: a multilayered body including a plurality of multilayered dielectric layers; and at least two filters, contained in the multilayered body, which are formed of an inductance element and a capacitance element, the filters having bands in which the center frequencies are different, wherein the inductance element which is a constituent of the filter is formed of at least one transmission line such that a plurality of transmission-line conductors are nearly opposed with each other with a dielectric layer in between along the multilayering direction of the multilayered body and are electrically connected in series so that the travelling directions of high-frequency signals which are propagated through two adjacent transmission-line conductors of the plurality of transmission-line conductors become the same.

[0013] The preferable combination of filters is a high-pass filter and a low-pass filter.

[0014] According to the high-frequency component of the present invention, since the transmission line which constitutes the inductance element in at least two filters having bands in which the center frequencies are different is formed of transmission-line conductors of plural layers, if the characteristic impedance of the transmission line is fixed, the length of the transmission-line conductor per layer can be shortened from that of the conventional case. Therefore, it is possible to realize a smaller size of the high-frequency component.

[0015] Also, since the travelling directions of the high-frequency signals which are propagated through two adjacent transmission-line conductors via a dielectric layer are the same, the circulation direction of a magnetic flux generated around each of the transmission-line conductors becomes the same. Therefore, by decreasing the spacing between the two adjacent transmission-line conductors via a dielectric layer, it is possible to increase the coupling between the two adjacent transmission-line conductors, making it possible to easily obtain a desired characteristic impedance.

[0016] As a result, since the transmission line is shut off from electromagnetic noise from an external source, even if the construction is formed such that a transmission line is disposed between two grounding electrodes, a decrease in the characteristic impedance of the transmission line due to the influence of stray capacitance generated between the transmission line and the ground is compensated for, making it possible to realize a higher characteristic impedance of the transmission line. Consequently, insertion loss and a reduction in the bandwidth of this high-frequency component can be suppressed. That is, it is possible to realize a high-frequency component having excellent frequency characteristics.

[0017] Furthermore, according to the high-frequency component of the present invention, since the high-frequency component is formed of a high-pass filter and a low-pass filter, the number of inductance elements and capacitors which constitute each filter can be decreased. Therefore, the high-frequency component can be formed into an even smaller size.

[0018] The above and further objects, aspects and novel features of the invention will become more apparent from the following detailed description when read in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019]

Fig. 1 is a circuit diagram of an embodiment of a high-frequency component according to the present invention.

Fig. 2 is a see-through perspective view of the high-frequency component of Fig. 1.

Figs. 3A, 3B, 3C, 3D, 3E, 3F, 3G, and 3H are top plan views of first to eighth dielectric layers which are constituents of the high-frequency component of Fig. 2.

Figs. 4A, 4B, 4C, and 4D are top plan views of ninth to twelfth dielectric layers which are constituents of the high-frequency component of Fig. 2; Fig. 4E is a bottom plan view of the twelfth dielectric layer.

Fig. 5 shows the frequency characteristics in a case in which the high-frequency component of Fig. 2 is used in a dual band of 800 MHz and 1.9 GHz.

Fig. 6 is a see-through perspective view showing an example of a conventional high-frequency component.

Figs. 7A, 7B, 7C, 7D, 7E, 7F, 7G, and 7H are top plan views of the first to eighth dielectric layers which are constituents of the high-frequency component of Fig. 6.

Figs. 8A and 8B are a top plan view and a bottom plan view of a ninth dielectric layer which is a constituent of the high-frequency component of Fig. 6.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0020] The preferred embodiment of the present invention will be described below with reference to the accompanying drawings.

[0021] Fig. 1 shows a circuit diagram of a preferred embodiment of a high-frequency component according to the present invention. In the high-frequency component 10, a high-pass filter (HPF) F1 is connected between a first port P1 and a second port P2, and a low-pass filter (LPF) F2 is connected between the first port P1 and a third port P3. In this case, the HPF F1 is composed of a transmission line L1, which is an inductance element, and capacitors C1 to C3, which are capacitance elements. The LPF F2 is composed of a transmission line L2, which is an inductance element, and capacitors C4 and C5, which are capacitance elements.

[0022] Specifically, in the HPF F1, a series circuit formed of the capacitors C1 and C2 is connected between the first port P1 and the second port P2, and the connection point of the capacitor C1 and capacitor C2 is grounded via a series circuit formed of the transmission line L1 and the capacitor C3.

[0023] Furthermore, in the LPF F2, a parallel circuit formed of the transmission line L2 and the capacitor C4 is connected between the first port P1 and the third port P3, and the connection point of the transmission line L2 and the capacitor C4 on the side closest to the third port P3 is grounded via a capacitor C5.

[0024] With this construction, a high-frequency signal of a high frequency region can be passed between the first port P1 and the second port P2, and a high-frequency signal of a low frequency region can be passed between the first port P1 and the third port P3. In this case, the transmission region of the HPF F1 and the transmission region of the LPF F2 are selected so that the transmission regions do not overlap each other.

[0025] For example, when an antenna is connected to the first port P1, a transmission circuit is connected to the second port P2, a receiving circuit is connected to the third port P3, and is used in PDC800 (Personal Digital Cellular 800 (trade name)), a transmission signal of 950 MHz output from the transmission circuit is passed through the HPF F1 and transmitted from the antenna. Meanwhile, a received signal of 820 MHz received by the antenna is passed through the LPF F2 and output to the receiving circuit.

[0026] In another example, when an antenna is connected to the first port P1, a transmission and receiving circuit corresponding to 1.9 GHz is connected to the second port P2, and a transmission and receiving circuit corresponding to 800 MHz is connected to the second port P3 so that high-frequency signals of a plurality of different frequency regions, for example, a high-frequency signal of PCS (Personal Communication Service) of 1.9 GHz and a high-frequency signal of AMPS (Advanced Mobile Phone Service) of 800 MHz, are distributed or coupled, the received signal of 1.9 GHz received by the antenna is passed through the HPF F1 and output to the receiving circuit of 1.9 GHz, and the received signal of 800 MHz received by the antenna is passed through the LPF F2 and output to the receiving circuit of 800 MHz. In contrast, a transmission signal output from the transmission circuit of 1.9 GHz is passed through the HPF F1 and output from the antenna, and a transmission signal output from a transmission circuit of 800 MHz is passed through the LPF F2 and output from the antenna. In this case, the high-frequency component can be used as a high-frequency distributor or a high-frequency coupler for a dual band. Therefore, the size of a mobile communication apparatus for a dual band can be reduced.

[0027] Fig. 2 shows a perspective view of the high-frequency component 10 of Fig. 1. As shown in Fig. 2, the high-frequency component 10 comprises a multilayer board 10a containing the HPF F1 and the LPF F2 (not shown). External terminals Ta to Tc are provided from a position near one of the long sides of the bottom surface of the multilayer board 10a to the side surface nearest to this long side. Also, external terminals Td to Tf are provided from a position near the other long side of the bottom surface of the multilayer board 10a to the side surface nearest to the other long side.

[0028] Figs. 3A to 3H, and Figs. 4A to 4D show top plan views of each dielectric layer which is a constituent of the high-frequency component 10 of Fig. 2, and Fig. 4E is a bottom plan view thereof. The high-frequency component 10 is formed in such a way that first to twelfth dielectric layers 11 to 22 are multilayered in sequence from the top.

[0029] Capacitor electrodes C11, C12, and C13 are printed and formed on the top surface of the second dielectric layer 12; capacitor electrodes C14 and C15 are printed and formed on the top surface of the third dielectric layer 13; capacitor electrodes C16, C17, and C18 are printed and formed on the top surface of the fourth dielectric layer 14; a capacitor electrode C19 is printed and formed on the top surface of the ninth dielectric layer 19; and a capacitor electrode C20 is printed and formed on the top surface of the eleventh dielectric layer 21, all of which electrodes are electrodes for forming capacitor elements.

[0030] Also, transmission-line conductors L11 and L12 having a nearly helical shape are printed and formed on the top surface of the fifth dielectric layer, and transmission-line conductors L13 and L14 having a nearly helical shape are printed and formed on the top surface of the sixth dielectric layer. In this case, the transmission-line conductors L11 and L13, and the transmission-line conductors L12 and L14 oppose each other with the fifth dielectric layer 15 in between.

[0031] Furthermore, grounding electrodes G11, G12, and G13 are printed and formed on the top surfaces of the eighth, tenth, and twelfth dielectric layers 18, 20, and 22, respectively. Also, external terminals Ta, Tc, and Te, which serve as first to third ports P1 to P3, and external terminals Tb, Td, and Tf, which serve as a grounding terminal, are formed on the bottom surface (Fig. 4E) of the twelfth dielectric layer 22.

[0032] Furthermore, in the second to eighth dielectric layers 12 to 18, viaholes VHb to VHh are provided at predetermined positions, respectively.

[0033] Next, the capacitor electrodes C11, C14, and C16 constitute the capacitor C1 of the HPF F1, the capacitor electrodes C12, C15, and C17 constitute the capacitor C2 of the HPF F1, and the capacitor electrode C19 and the grounding electrodes G11 and G12 constitute the capacitor C3 of the HPF F1. The capacitor electrodes C13 and C18 constitute the capacitor C4 of the HPFF 2, and the capacitor electrode C20 and the grounding electrodes G12 and G13 constitute the capacitor C5 of the HPFF 2.

[0034] The transmission-line conductors L11 and L13, and the transmission-line conductors L12 and L14 are electrically connected in series (Figs. 3E and 3F) so that the travelling directions of high-frequency signals which are propagated through the viahole VHe provided in the fifth dielectric layer 15 becomes the same, forming one transmission line L1 which is a constituent of the HPF F1 and one transmission line L2 which is a constituent of the LPF F2, respectively.

[0035] Fig. 5 shows the frequency dependence of the transmission characteristics between the first port P1 and the second port P2 and between the first port P1 and the third port P3 in a high-frequency component for a dual band for use with the above-described PCS of 1.9 GHz and AMPS of 800 MHz. In Fig. 5, the solid line indicates transmission characteristics between the first port P1 and the second port P2, and the broken line indicates transmission characteristics between the first port P1 and the third port P3.

[0036] It can be understood from this figure that between the first port P1 and the second port P3, nearly zero (dB) is shown near 1.9 GHz, and between the first port P1 and the third port P2, nearly zero (dB) is shown near 800 MHz. This shows that in the above-described construction, interference between the high-frequency signal of 1.9 GHz and the high-frequency signal of 800 MHz is suppressed sufficiently.

[0037] As described above, according to the high-frequency component of the above-described embodiment, a transmission line of a high-pass filter connected between a first port and a second port and a transmission line of a low-pass filter connected between the first port and a third port are formed by two adjacent transmission-line conductors via a dielectric layer. Therefore, if the characteristic impedance of the transmission line is fixed, the length of the transmission-line conductor per layer can be reduced by approximately half that of a conventional case.

[0038] Therefore, the high-frequency component of this embodiment is able to secure the characteristic impedance of the transmission line at a predetermined value at a part size smaller than that of a conventional high-frequency component, thereby achieving a smaller size of the high-frequency component. Specifically, when the outer dimensions of the high-frequency component of this embodiment comprising a transmission line having nearly the same characteristic impedance is compared with the outer dimensions of the conventional high-frequency component, the dimensions of the conventional high-frequency component are 4.5 mm (L) × 3.2 mm (W) × 1.0 mm (H), and the dimensions of the high-frequency component of this embodiment are 3.2 mm (L) × 2.5 mm (W) × 1.1 mm (H), which is 2/3 or less in terms of volume.

[0039] Also, since the travelling directions of high-frequency signals which are propagated through two adjacent transmission-line conductors via a dielectric layer are the same, the circulation direction of a magnetic flux generated around each of the transmission-line conductors becomes the same. Therefore, the two adjacent transmission-line conductors with a dielectric layer in between are electromagnetically connected by a magnetic flux circulating in the same direction, and a magnetic flux circulating about the two adjacent transmission-line conductors is generated in a portion where two adjacent transmission-line conductors are close to each other and-overlap each other.

[0040] As a result, by decreasing the spacing between the two adjacent transmission-line conductors, it is possible to increase the coupling between the two adjacent transmission-line conductors, making it possible to easily obtain a desired characteristic impedance. Therefore, since the transmission line is shut off from electromagnetic noise from an external source, even if the construction is formed such that a transmission line is disposed between two grounding electrodes, a decrease in the characteristic impedance of the transmission line due to the influence of stray capacitance generated between the transmission line and the ground is compensated for, making it possible to realize a higher characteristic impedance of the transmission line. Consequently, the insertion loss of this high-frequency component and a reduction in the bandwidth can be suppressed. That is, it is possible to realize a high-frequency component having excellent frequency characteristics.

[0041] In addition, since the high-frequency component is formed of a high-pass filter and a low-pass filter, the number of transmission lines and capacitors which constitute each filter can be decreased. Therefore, the high-frequency component can be formed into an even smaller size.

[0042] In the above-described embodiment, the circuit diagram of the high-frequency component, and the top plan views and the bottom plan views of each dielectric layer which is a constituent of the high-frequency component, shown in Figs. 1, 3A to 3H, and 4A to 4E, are examples. A high-frequency component is within the scope of the present invention as long as the transmission line which constitutes an inductance element, formed of a plurality of transmission-line conductors electrically connected in series, is formed of a plurality of transmission-line conductors which are nearly opposed with each other with a dielectric layer in between along the multilayering direction of the multilayered body and which are electrically connected in series so that the travelling directions of the high-frequency signals propagated through two adjacent transmission-line conductors of the plurality of transmission-line conductors becomes the same.

[0043] Although a case in which the transmission-line conductor takes a nearly helical shape is described, in addition to the helical shape, the transmission-line conductor may have a spiral shape, a meandering shape, or a combination thereof depending upon the specifications of the occupied area and desired characteristic impedance.

[0044] Furthermore, although a case in which the combination of a plurality of filters is a high-pass filter and a low-pass filter is described, for example, other combinations are possible, such as a band-pass filter and a band-elimination filter, a band-pass filter and a band pass filter, or a band-elimination filter and a band-elimination filter.

[0045] Many different embodiments of the present invention may be constructed without departing from the spirit and scope of the present invention. It should be understood that the present invention is not limited to the specific embodiment described in this specification. To the contrary, the present invention is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the invention as hereafter claimed. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications, equivalent structures and functions.

Claims

1. A high-frequency component, comprising:

a multilayered body (10a) including a plurality of multilayered dielectric layers (11 - 22);
at least two filters (F1, F2), contained in the multilayered body (10a), which are formed of an inductance elements (L1, L2) and a capacitance element (C1 - C3, C4, C5), said filters having bands in which the center frequencies are different; and
the inductance element constituting said filter being formed of at least one transmission line (L1, L2) such that a plurality of transmission-line conductors (15, 16) are nearly opposed with each other with a dielectric layer in between along the multilayering direction of said multilayered body (10a) and are electrically connected in series so that the travelling directions of high-frequency signals which are propagated through two adjacent transmission-line conductors of said plurality of transmission-line conductors become the same.

2. A high-frequency component according to claim 1, wherein said at least two filters (F1, F2) include a high-pass filter and a low-pass filter.

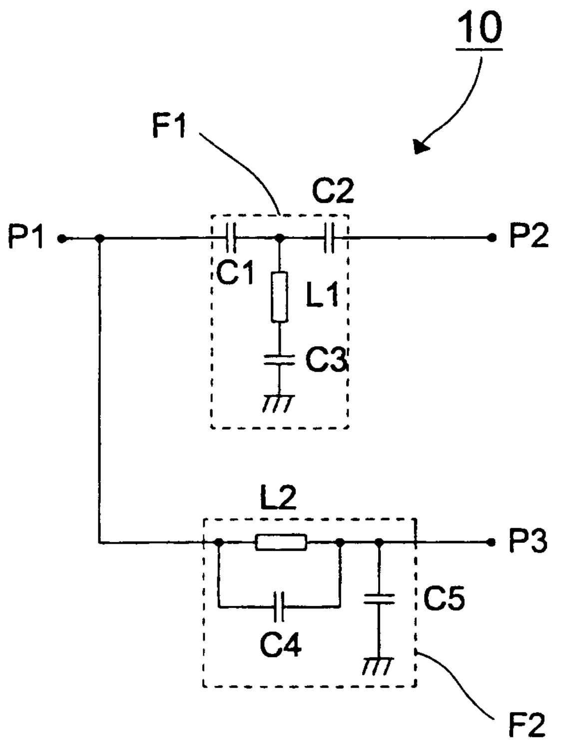


FIG.1

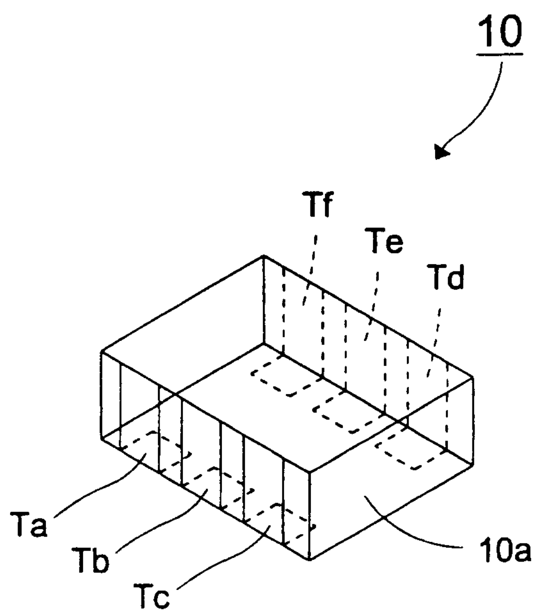


FIG.2

FIG.3A

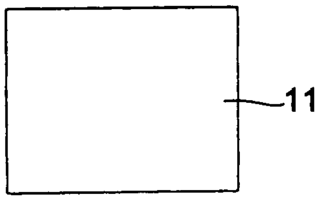


FIG.3B

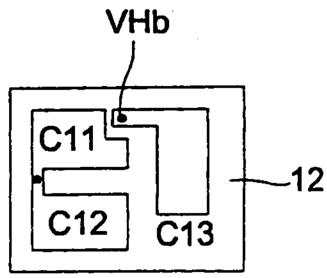


FIG.3C

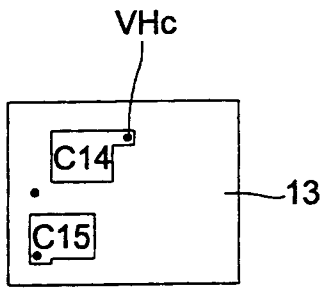


FIG.3D

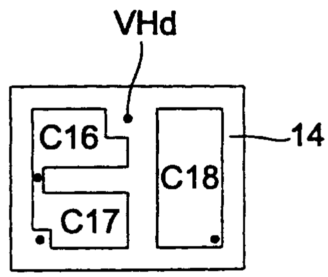


FIG.3E

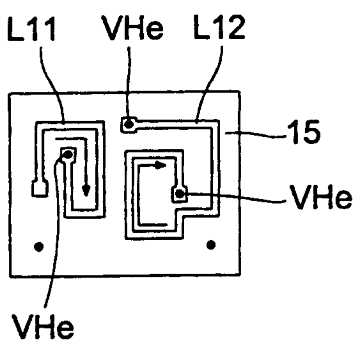


FIG.3F

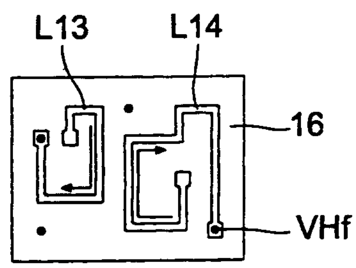


FIG.3G

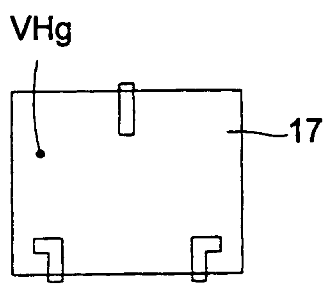


FIG.3H

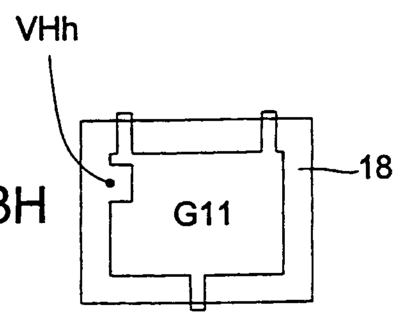


FIG.4A

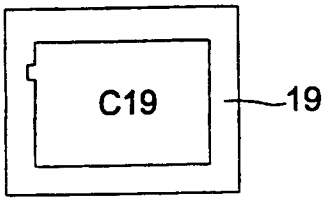


FIG.4B

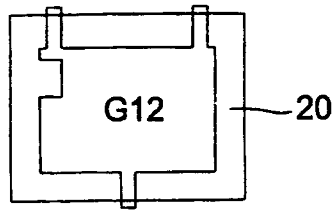


FIG.4C

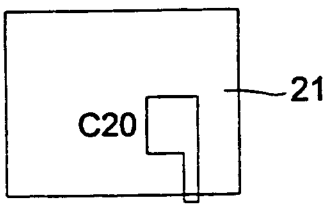


FIG.4D

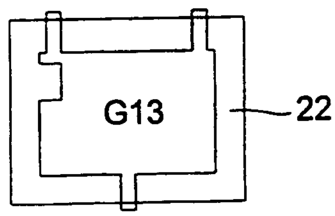
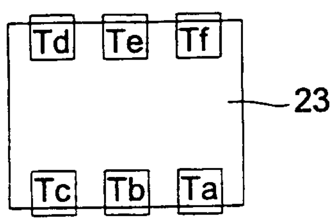


FIG.4E



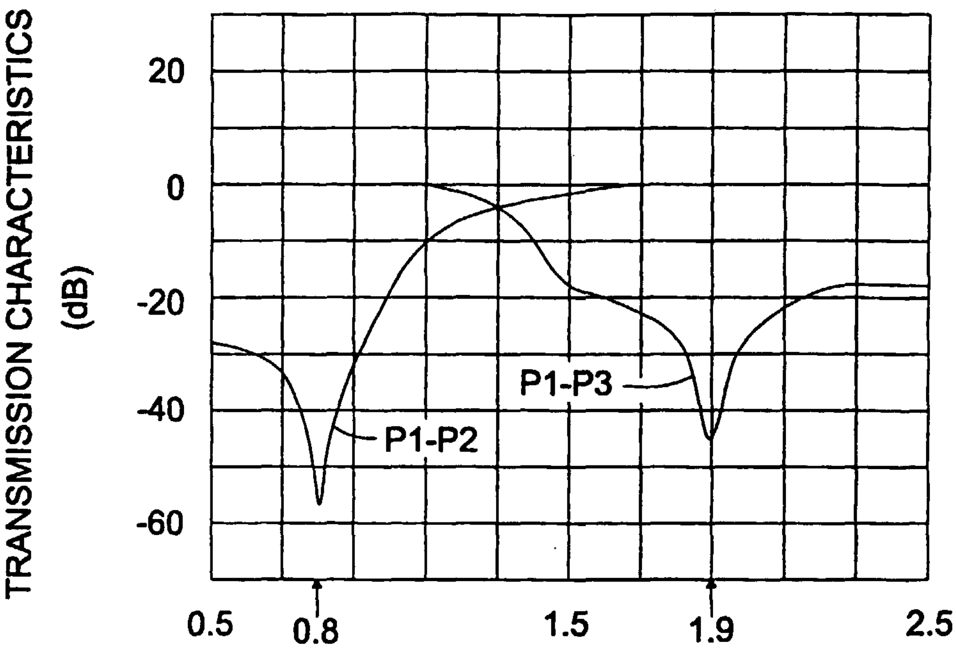
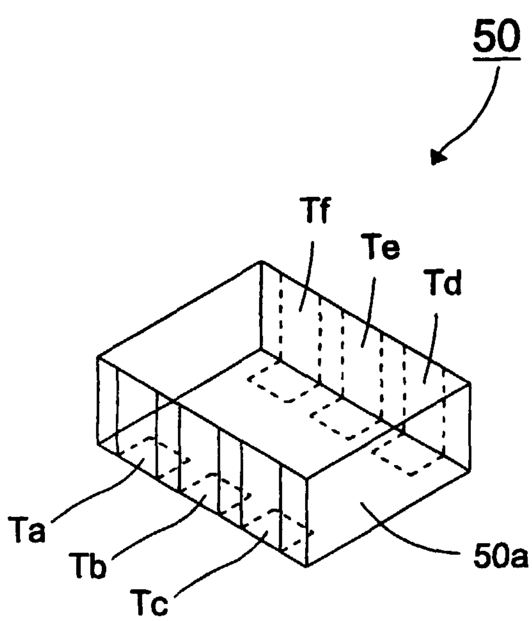


FIG.5



PRIOR ART

FIG.6

PRIOR ART

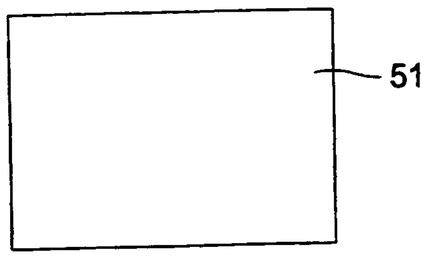


FIG.7A

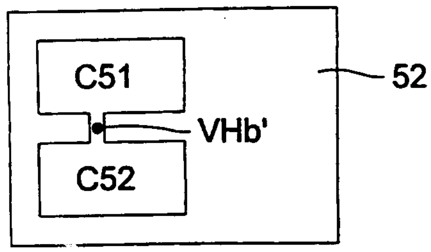


FIG.7B

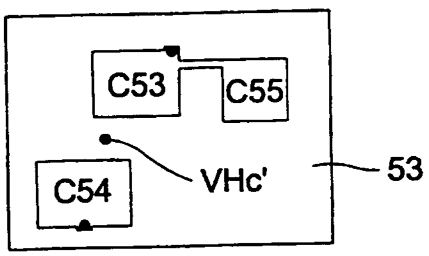


FIG.7C

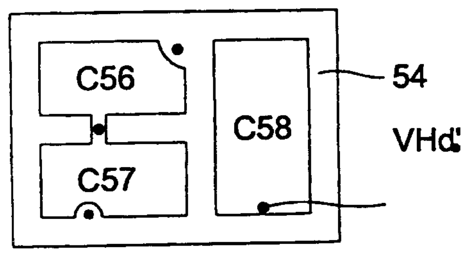


FIG.7D

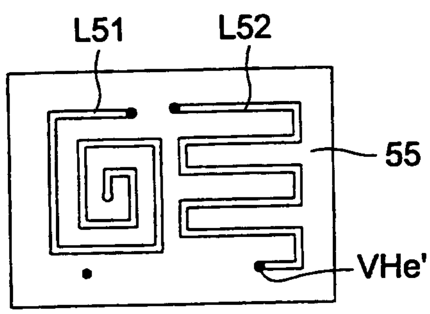


FIG.7E

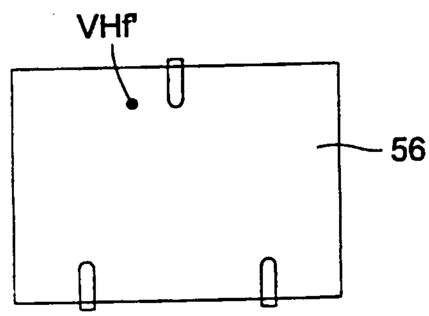


FIG.7F

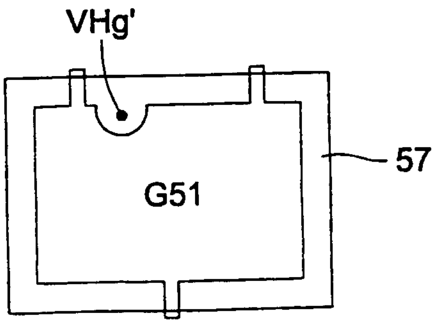


FIG.7G

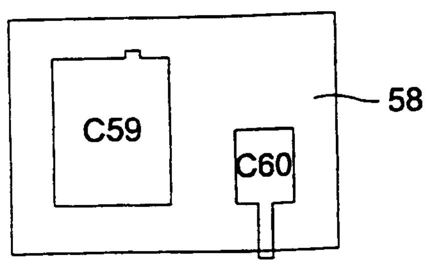


FIG.7H

PRIOR ART

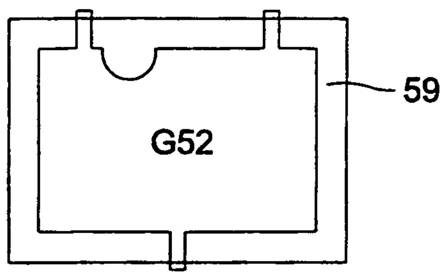


FIG.8A

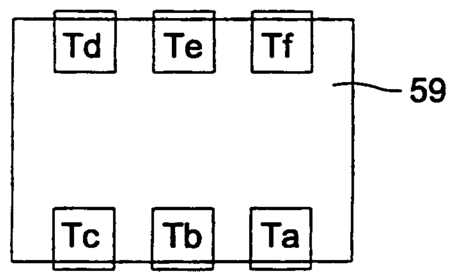


FIG.8B