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(54) Antenna device and portable radio communication device comprising such antenna device

(57) An triple band antenna device for a portable radio communication device comprises a ground plane (10), a first radiating element divided into a first portion (HB1) having a first resonance frequency corresponding to the higher frequency band and a second portion (LB) having a second resonance frequency corresponding to the lower frequency band. A second radiating element (30) comprises a radiating portion (HB2) having a third resonance frequency corresponding to the third frequency band substantially higher than the lower frequency band. The second portion (LB) of the first radiating element is provided between the first portion (HB1) of the first radiating element and the radiating portion (HB2) of the second radiating element, thereby improving isolation between the two radiating portions having high resonance frequencies.

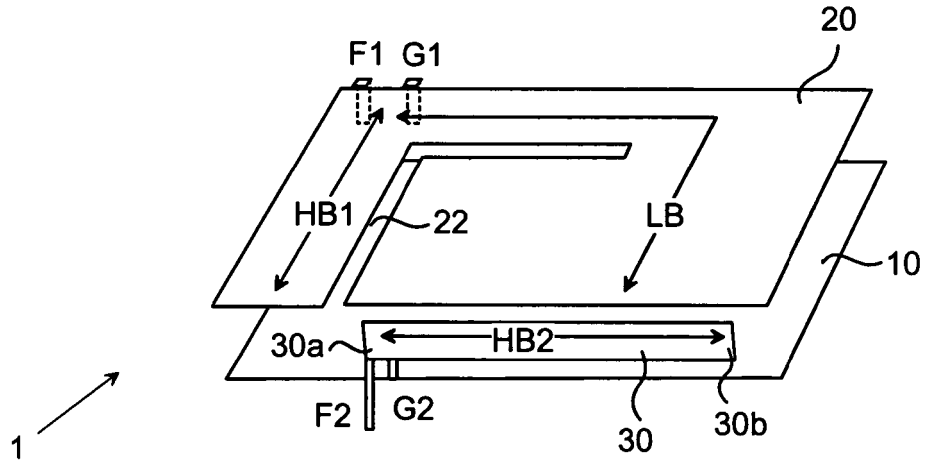

Fig. 1

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Description

FIELD OF INVENTION

[0001] The present invention relates generally to antenna devices and more particularly to a controllable internal multi-band antenna device for use in portable radio communication devices, such as in mobile phones. The invention also relates to a portable radio communication device comprising such an antenna device.

BACKGROUND

[0002] Internal antennas have been used for some time in portable radio communication devices. There are a number of advantages connected with using internal antennas, of which can be mentioned that they are small and light, making them suitable for applications wherein size and weight are of importance, such as in mobile phones.

[0003] With increasing demand on multi-functionality of portable radio communication devices complementary antenna devices are increasingly being provided in mobile phones, for example. One such example is when the cellular antenna device conventionally provided in the mobile phone and operating in frequency bands up to 1.9 GHz is complemented with an antenna device operating in a higher frequency band, such as an antenna device operating in the Bluetooth band, i.e., around 2.4 GHz.

[0004] However, a problem arising when several radiating antenna elements operating in different frequency bands are provided in a relatively small device, such as on the same antenna carrier in a mobile phone, is interference between the different radiating antenna elements, resulting in degraded performance and increased losses.

SUMMARY OF THE INVENTION

[0005] An object of the present invention is to provide an antenna device of the kind initially mentioned wherein several radiating antenna elements are provided in a small space while retaining adequate isolation between the different radiating antenna elements.

[0006] The invention is based on the realization that the provision of an antenna element resonating in

[0007] According to a first aspect of the present invention there is provided an antenna device as defined in claim 1.

[0008] According to a second aspect of the present invention there is provided a portable radio communication device comprising such an antenna device.

[0009] Further preferred embodiments are defined by the dependent claims.

[0010] Thus there is provided a small sized antenna device with adequate isolation between the different radiating antenna elements.

BRIEF DESCRIPTION OF DRAWINGS

[0011] The invention is now described, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is a perspective view illustrating a first embodiment of an antenna device according to the invention;

Fig. 2 is a planar view of the antenna device illustrated in Fig. 1;

Fig. 2a is a frequency diagram for the antenna device of Fig. 2; and

Figs. 3-6 are planar views illustrating different alternative embodiments of an antenna device according to the invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0012] In the following, a detailed description of preferred embodiments of an antenna device according to the invention will be given. In the description, for purposes of explanation and not limitation, specific details are set forth, such as particular hardware, applications, techniques etc. in order to provide a thorough understanding of the present invention. However, it will be apparent to one skilled in the art that the present invention may be utilized in other embodiments that depart from these specific details. In other instances, detailed descriptions of well-known methods, apparatuses, and circuits are omitted so as not to obscure the description of the present invention with unnecessary details.

[0013] In fig. 1, there is shown an antenna device, generally designated 1, which is arranged for multi-band operation The antenna device comprises a generally planar ground plane 10 which can be part of a printed circuit board in a portable radio communication device, such as a mobile phone. A first generally planar rectangular radiating element 20 is provided above and essentially parallel to the ground plane 10. This radiating element is made of an electrically conductive material, such as a sheet metal or a flex film provided on a dielectric carrier (not shown), as is conventional. The first radiating element 20 comprises a first feeding portion (F1) arranged to be connected to RF circuitry (not shown) provided in the communication device.

[0014] A first grounding portion G1 of the first radiating element is connected to the ground plane 10.

[0015] The first radiating element 20 is divided by means of an L-shaped slot 22 into a first portion HB1 having a first resonance frequency corresponding to a first frequency band and a second portion LB having a second resonance frequency corresponding to an second frequency band substantially lower than the first fre-

quency band. The upper and lower frequency bands can be the GSM 1800 and GSM 900 band, respectively.

[0016] A planar second radiating element 30 comprising a radiating portion HB2 is provided essentially vertically along the front edge of the first radiating element 20. The second radiating element comprises a second feeding portion F2 connectable to RF circuitry, such as a Bluetooth circuit operating in a frequency band around 2.4 GHz. This second radiating element 30 thus has a third resonance frequency corresponding to a third frequency band substantially higher than the second frequency band LB. The second radiating element 30 also comprises a second grounding portion G2 connected to the ground plane 10. Thus, the second radiating element has first 30a and second 30b opposite end portions, wherein the second feeding and grounding portions are provided at the first end 30a.

[0017] From Figs. 1 and 2 it is evident that the second, i.e., low frequency portion LB of the first radiating element is provided between the first, i.e., high frequency portion HB1 of the first radiating element and the radiating portion HB2 of the second radiating element 30.

[0018] The high frequency band of the first radiating element and the frequency band of the second radiating element are relatively close to each other. It should also be noted that the distance between the first end 30a of second radiating element and the first portion HB1 of the first radiating element 20 is shorter than the distance between the second end 30b of the second radiating element and the first portion HB1 of the first radiating element. This normally means the isolation between them is low, i.e., the two frequency bands tend to disturb each other. However, with the shown configuration, the isolation between HB1 and HB2 remains high. It is believed that the low band portion LB of the first radiating element functions to improve the isolation between the two other portions HB1 and HB2 due to the fact that the low band portion resonates at a substantially lower frequency than the other portions. By "substantially lower frequency" is in this context meant approximately half the frequency of the high frequency bands.

[0019] An exemplary frequency vs. attenuation diagram for the antenna device of Figs. 1 and 2 is shown in Fig. 2a, wherein the parameters S11, S21, and S22 are shown.

[0020] In a second embodiment shown in Fig. 3, the second antenna element 30 is provided along the short right-hand side of the first radiating element 20. This second embodiment is in all other aspects similar to the first embodiment of the antenna device.

[0021] In this second embodiment the second portion LB of the first radiating element 20 is entirely provided between the first portion HB1 of the first radiating element and the second radiating element HB2.

[0022] In a third embodiment shown in Fig. 4, the second antenna element 30 is provided along the long upper side of the first radiating element 20. This second embodiment is in all other aspects similar to the first embodiment of the antenna device.

[0023] In a fourth embodiment shown in Fig. 5, the slot 22 has a different extension than in the previously described embodiments. In this embodiment, the slot extends from the upper edge of the first radiating element 20, i.e., the edge at which the first feeding portion F1 and the first grounding portion G1 are provided. However, the slot still divides the first radiating element into a first portion HB1 having a first resonance frequency corresponding to a first frequency band and a second portion LB having a second resonance frequency corresponding to an second frequency band substantially lower than the first frequency band.

[0024] The second radiating element 30 is provided along the short right-hand edge of the first radiating element 20. The feeding and grounding portions F2, G2 of the second radiating element are provided at a first end of the second radiating element 30 close to the lower right corner of the first radiating element 20. A second end of the second radiating element 30 opposite to the first end is bent around the upper right corner of the first radiating element. Thus, part of the second radiating element 30 is provided at the same side of the first radiating element as the first feeding and grounding portions F1, G1.

[0025] A fifth embodiment shown in Fig. 6 is similar to the fourth embodiment shown in Fig. 5 with the exception that the second feeding and grounding portions F2, G2 are provided at the second end of the second radiating element 30.

[0026] Preferred embodiments of an antenna device according to the invention have been described. However, it will be appreciated that these can be varied within the scope of the appended claims. Thus, the radiating elements have been described as being essentially planar and generally rectangular. It will be appreciated that the radiating elements can take any suitable shape, such as being bent to conform to the casing of the portable radio communication device in which the antenna device is mounted.

[0027] The complementary radiating element 30 has been described as a Bluetooth antenna element. It will be appreciated that this radiating element can be provided for other applications as well as long as the frequency band HB2 thereof is substantially higher than the frequency band of the low band portion LB of the first radiating element 20.

Claims

1. An antenna device for a portable radio communication device, wherein the antenna device is arranged for operation in a first, a second, and a third frequency band, the antenna device comprising:

   - a ground plane (10);
   - a first radiating element (20) provided at a dis-

tance from the ground plane,
- a first feeding portion (F1) connected to the first radiating element;
- a first grounding portion (G1) connected to the first radiating element;
- wherein the first radiating element is divided into a first portion (HB1) having a first resonance frequency corresponding to the first frequency band and a second portion (LB) having a second resonance frequency corresponding to the second frequency band, wherein the second resonance frequency is substantially lower than the first resonance frequency; and
- a second radiating element (30) comprising a radiating portion (HB2) having a third resonance frequency corresponding to a third frequency band, wherein the third resonance frequency is substantially higher than the second resonance frequency;
- a second feeding portion (F2) connected to the second radiating element;
- a second grounding portion (G2) connected to the second radiating element;

characterized in that

- the second portion (LB) of the first radiating element is provided between the first portion (HB1) of the first radiating element and the radiating portion (HB2) of the second radiating element.

2. The antenna device according to claim 1, wherein the second radiating element (30) is elongated and has first and second opposite end portions, and wherein the second feeding and grounding portions are provided at the first end of the second radiating element.

3. The antenna device according to claim 2, wherein the distance between the first end (30a) of second radiating element and the first portion (HB1) of the first radiating element (20) is shorter than the distance between the second end (30b) of the second radiating element and the first portion (HB1) of the first radiating element (20).

4. The antenna device according to claim 1, wherein the first feeding portion (F1), the first grounding portion (G1), the second feeding portion (G2), and the second grounding portion (G2) all are provided at the same side of the first radiating element (20).

5. The antenna device according to claim 1, wherein the second radiating element (30) is provided along two adjacent edges of the first radiating element (20).

6. The antenna device according to any of claims 1-5, wherein the first radiating element is divided into a first portion (HB1) a second portion (LB) by means of a slot (22).

7. The antenna device according to claim 6, wherein the slot (22) is L-shaped.

8. The antenna device according to any of claims 1-7, wherein the third resonance frequency is about 2.4 GHz.

9. The antenna device according to any of claims 1-8, wherein the first resonance frequency is about 1900 MHz and the second resonance frequency is about 900 MHz.

10. A portable radio communication device comprising an antenna device according to claim 1.

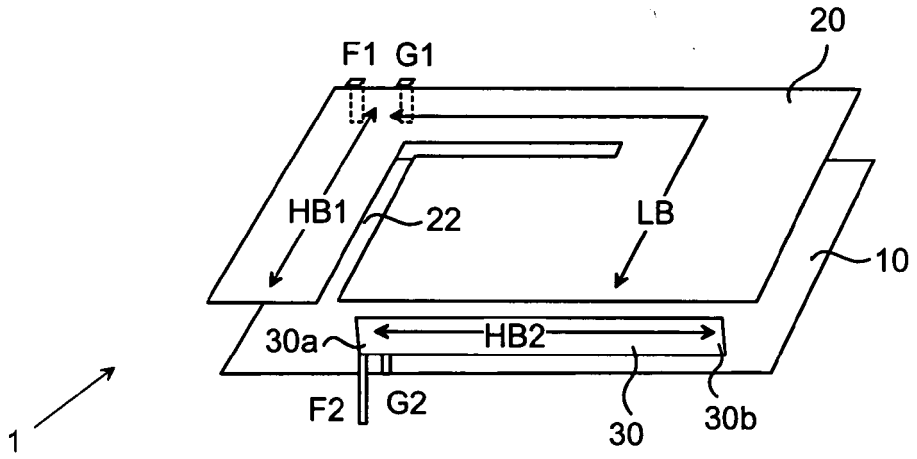

Fig. 1

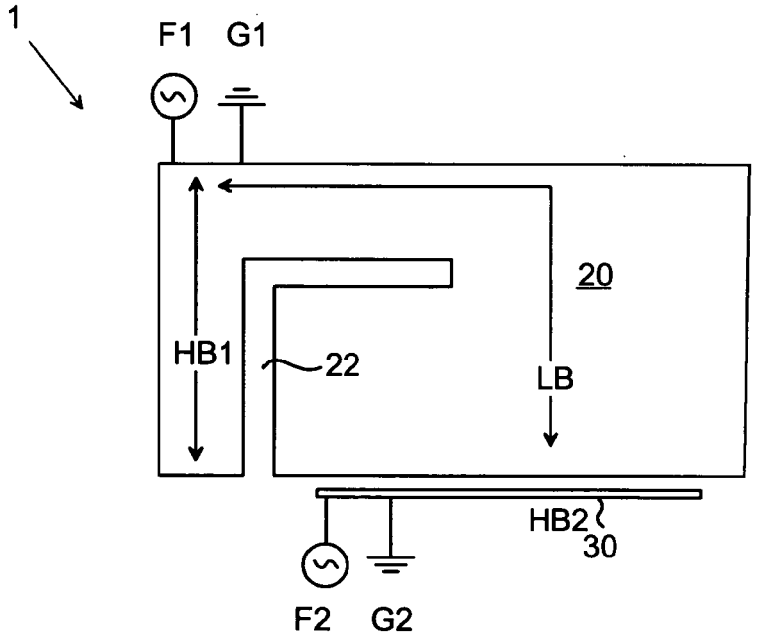

Fig. 2

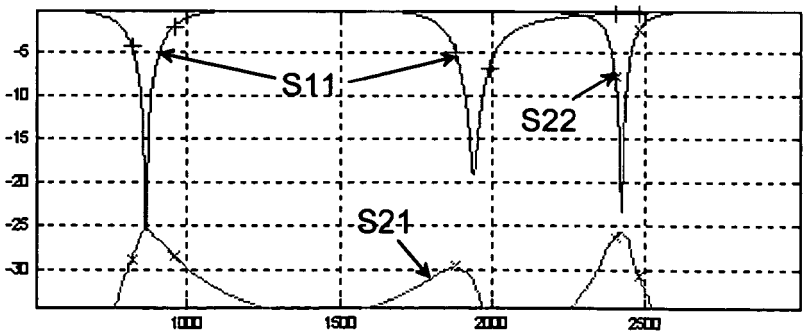

Fig. 2a

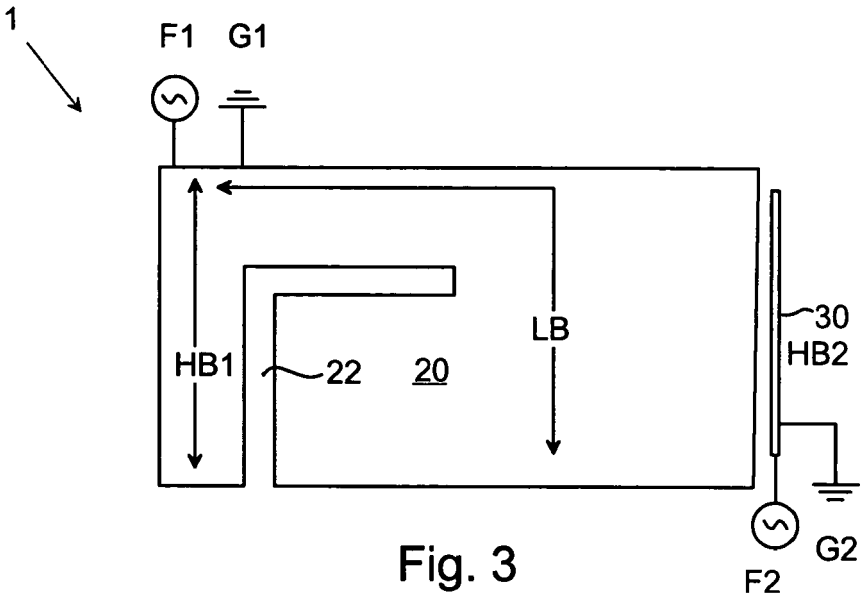

Fig. 3

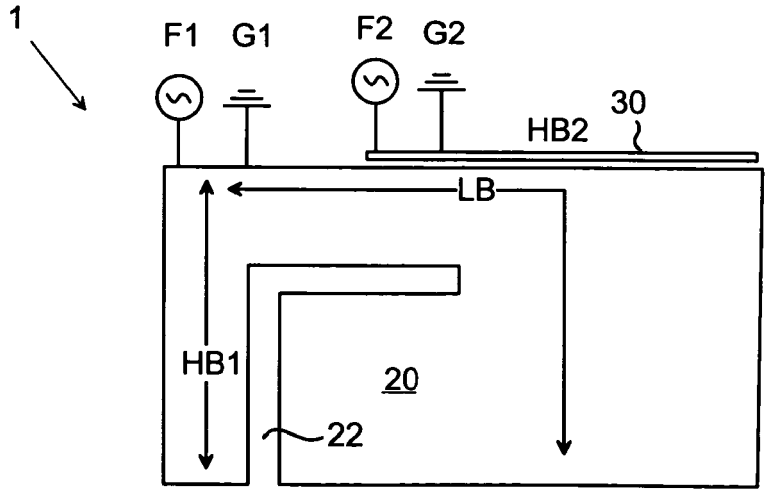

Fig. 4

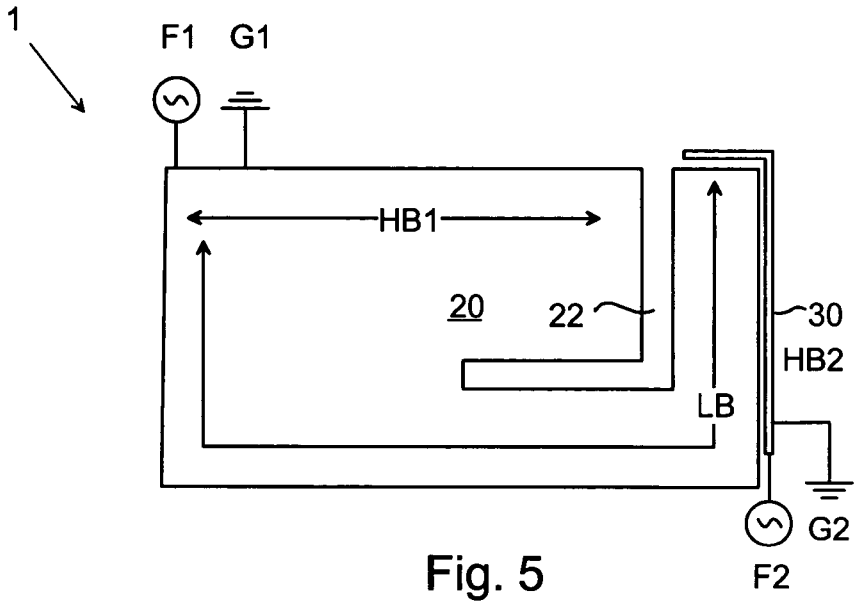

Fig. 5

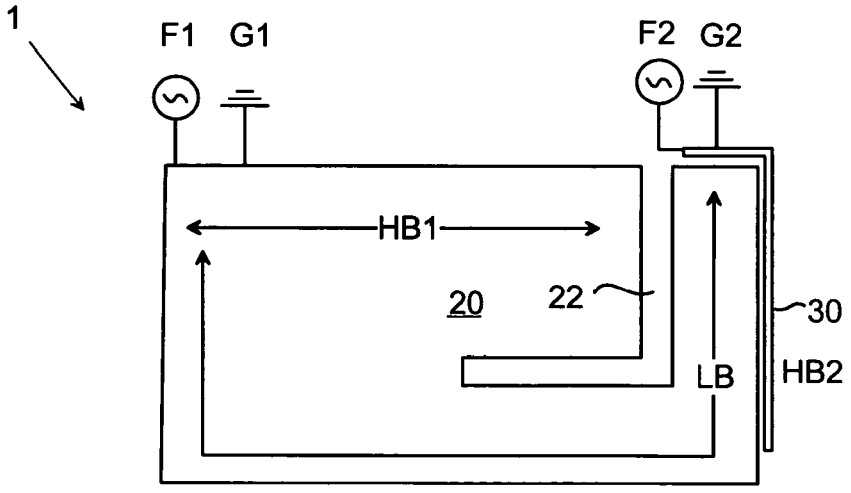

Fig. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 06 44 5027

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 1 560 287 A (HIGH TECH COMP CORP [TW]) 3 August 2005 (2005-08-03) * paragraphs [0016] - [0019]; figures 1-3 *	1-10	INV. H01Q1/24 H01Q21/28 H01Q9/04
X	WO 02/078123 A (ERICSSON TELEFON AB L M [SE]; BOLIN THOMAS [SE]; YING ZHINONG [CN]; AN) 3 October 2002 (2002-10-03) * paragraphs [0016] - [0018]; figures 6-12 *	1-10	
X	US 6 448 932 B1 (STOILJKOVIC VLADIMIR [GB] ET AL) 10 September 2002 (2002-09-10) * paragraphs [0005] - [0021]; figures 1-4 *	1-10	
X	WO 02/31921 A2 (NOKIA CORP [FI]; NOKIA INC [US]) 18 April 2002 (2002-04-18) * the whole document *	1-10	
X	US 6 408 190 B1 (YING ZHINONG [SE]) 18 June 2002 (2002-06-18) * the whole document *	1-10	TECHNICAL FIELDS SEARCHED (IPC) H01Q
X	US 6 476 769 B1 (LEHTOLA ANTERO [FI]) 5 November 2002 (2002-11-05) * paragraphs [0003], [0036], [0037], [0041] - [0043] *	1-4,6-10	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	2 November 2006	Fredj, Aziz

CATEGORY OF CITED DOCUMENTS

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02-11-2006

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1560287 A	03-08-2005	NONE	
WO 02078123 A	03-10-2002	EP 1378021 A1	07-01-2004
US 6448932 B1	10-09-2002	NONE	
WO 0231921 A2	18-04-2002	AU 9218201 A	22-04-2002
		US 2002089454 A1	11-07-2002
US 6408190 B1	18-06-2002	AT 265094 T	15-05-2004
		AU 6572800 A	26-03-2001
		CN 1384986 A	11-12-2002
		DE 60010099 D1	27-05-2004
		DE 60010099 T2	02-09-2004
		WO 0117063 A1	08-03-2001
		EP 1212808 A1	12-06-2002
		JP 2003516650 T	13-05-2003
US 6476769 B1	05-11-2002	CN 1409437 A	09-04-2003
		DE 60200508 D1	24-06-2004
		DE 60200508 T2	30-06-2005
		EP 1296410 A1	26-03-2003
		JP 2003124730 A	25-04-2003

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