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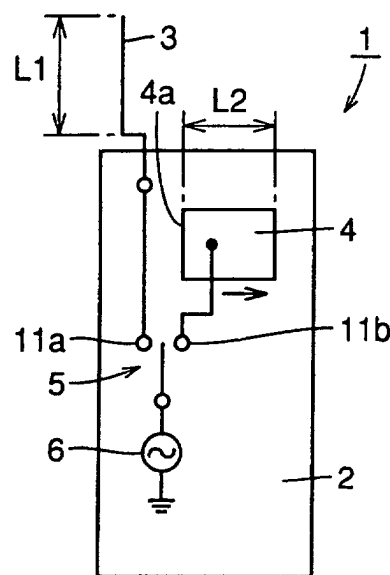
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(54) **PORTABLE RADIO DEVICE**

(57) A portable radio of the present invention includes: a casing (2); a first antenna (3) capable of being pulled out from the casing (2); a second plate-like antenna (4) contained in the casing (2) and connected to a ground substrate (13); and a power supply means (6) for exciting at least one of the first antenna (3) and the second antenna (4).

FIG. 1A



Description

Technical Field

[0001] The present invention relates to portable radios or mobile radio sets and, more specifically to a portable radio provided with two types of antennae.

Background Art

[0002] One example of a portable radio provided with two types of antennae is disclosed in Japanese Utility Model Laying-Open No. 61-42148.

[0003] The portable radio disclosed in the aforementioned laid-open application includes a whip antenna capable of being freely pushed in or pulled out from a casing, and a small antenna contained in the casing. For remote communication, the whip antenna is pulled out from the casing and connected to a transmission/reception circuit for communication. For local communication, the whip antenna is contained in the casing, and the internal small antenna is connected to the transmission/reception circuit for communication.

[0004] However, the aforementioned document does not contain details such as the shapes of the internal small antenna and whip antenna. Thus, if these antennae are simply combined, a problem of inefficiency may arise due to antenna coupling.

Disclosure of the Invention

[0005] The present invention is made to solve the aforementioned problem. An object of the present invention is to alleviate the inefficiency problem due to antenna coupling in a portable radio or a mobile radio set provided with two types of antennae.

[0006] In one aspect, a portable radio or a mobile radio set of the present invention includes a casing, a first linear antenna capable of being pulled out from the casing, a second plate-like antenna contained in the casing and connected to a ground substrate, and a power supply or feeding means for exciting at least one of the first and second antennae.

[0007] Having intensively studied to alleviate the inefficiency problem due to antenna coupling in a portable radio provided with two types of antennae, the present inventor has found that the combination of the first linear antenna and the second plate-like antenna connected to the ground substrate provides smaller antenna coupling, as shown in Fig. 7. As a result, the inefficiency due to inter-antenna interference can be alleviated.

[0008] The portable radio preferably includes a switching means between the first and second antennae, and the power supply means.

[0009] The above mentioned switching means may connect the first antenna and power supply means when the first antenna is pulled out, and connect the second antenna and power supply means when the first antenna

is pushed in.

[0010] The switching means may connect both the first and second antennae to the power supply means when the first antenna is pulled out, and connect the second antenna to the power supply means when the first antenna is pushed in.

[0011] Further, the switching means may connect both the first and second antennae to the power supply means when the first antenna is pulled out, and also connect both the first and second antennae to the power supply means when the first antenna is pushed in.

[0012] Furthermore, the switching means may connect the first antenna to the power supply means when the first antenna is pulled out, and connect both the first and second antennae to the power supply means when the first antenna is pushed in.

[0013] The first antenna preferably includes a monopole antenna having a length which is an integral multiple of a half wavelength. The second antenna preferably includes a patch antenna. Further, the first antenna may include a helical antenna arranged in series with the monopole antenna.

[0014] It is preferred that the first antenna is inclined toward the side opposite a human body. In this way, the antenna performance becomes less affected by the human body.

[0015] In another aspect, a portable radio of the present invention includes a casing having a flip, a first antenna provided in the flip, a second plate-like antenna contained in the casing and connected to the ground substrate, and a power supply means for exciting at least one of the first and second antennae.

[0016] The above combination of the first and second antennae also provides smaller antenna coupling as in the invention according to the above mentioned one aspect.

[0017] The above mentioned portable radio preferably includes a switching means between the first and second antennae and the power supply means.

[0018] The switching means may connect the first antenna to the power supply means when the flip is opened, and connect the second antenna to the power supply means when the flip is closed.

[0019] Further, the switching means may connect both the first and second antennae to the power supply means when the flip is opened, and connect the second antenna to the power supply means when the flip is closed.

[0020] Furthermore, the switching means may connect both the first and second antennae to the power supply means when the flip is opened, and connect the first and second antennae to the power supply means when the flip is closed.

[0021] Moreover, the switching means may connect the first antenna to the power supply means when the flip is opened, and connect both the first and second antennae to the power supply means when the flip is closed.

Brief Description of the Drawings

[0022]

Fig. 1A is a diagram schematically showing a portable radio according to a first embodiment of the present invention.

Fig. 1B is a side view of the portable radio in Fig. 1A.

Fig. 1C is an equivalent circuit diagram of the portable radio in Fig. 1A.

Fig. 1D is an equivalent circuit diagram of the portable radio in Fig. 1A.

Fig. 1E is a side view of an internal antenna of the portable radio in Fig. 1A.

Fig. 2A is a diagram schematically showing a portable radio according to a second embodiment of the present invention.

Fig. 2B is a side view of the portable radio in Fig. 2A.

Figs. 3A and 3B are equivalent circuit diagrams of a portable radio according to a third embodiment of the present invention.

Figs. 4A and 4B are diagrams schematically showing a portable radio according to a fourth embodiment of the present invention.

Figs. 5A and 5B are diagrams schematically showing a portable radio according to a fifth embodiment of the present invention.

Figs. 6A and 6B are diagrams schematically showing a portable radio according to a sixth embodiment of the present invention.

Fig. 7 is a graph showing a measurement result of antenna coupling in the portable radio of the present invention.

Best Modes for Carrying Out the Invention

[0023] Now, the embodiments of the present invention will be described with reference to Figs. 1A to 7.

First embodiment

[0024] Figs. 1A to 1D show a portable radio or a mobile radio set 1 such as a portable radio telephone of the first embodiment of the present invention as well as modifications thereof. Fig. 1E is a side view of the internal antenna shown in Fig. 1A.

[0025] As shown in Fig. 1A, portable radio 1 includes a casing 2, a first antenna 3, a second antenna 4, a switch 5, and a power supply means 6.

[0026] As shown in Fig. 1E, casing 2 contains a ground substrate 13 on which second antenna 4 is mounted. First antenna is preferably a monopole antenna, which can be freely pulled out from and pushed in casing 2. A length L1 of first antenna 3 is an integral (at least 1) multiple of a half wavelength (λ). Thus, the current to casing 2 can be controlled when pulling out.

[0027] Second antenna 4 is contained in casing 2 and is preferably a short patch antenna. Second antenna 4

is rectangular when viewed from above in Fig. 1A, having at one end 4a a short-circuit board 12, and is connected to substrate 13 through short-circuit board 12. In addition, second antenna 4 has a length L2 in the width direction of casing 2 of for example $\lambda/4$.

[0028] The present inventor has found that the combination of first linear antenna 3 and second plate-like antenna 4 connected to ground substrate 13 provides smaller antenna coupling (about -20dB to -30dB) in the applied band as shown in Fig. 7 although the antennae are maintained fairly close to each other despite a large wavelength. Thus, the inefficiency problem due to an interference between antennas can be alleviated.

[0029] Further, the above mentioned second plate-like antenna 4 provides a radiation field by the combination of currents flowing through a portion parallel to ground substrate 13 and short-circuit board 12. As a result, omnidirectionality is obtained in the plane including the direction normal to the substrate and the direction from short-circuit board 12 toward the power supply point side, when viewing the substrate from above as a rectangular shape.

[0030] Further, since second antenna 4 is laterally arranged as shown in Fig. 1A, second antenna 4 does not have directionality in the plane orthogonal to the longitudinal direction of the casing and polarized waves become orthogonal to the longitudinal direction of the casing. Thus, when mounted obliquely to the human body, the polarized waves become generally vertical to the ground, whereby polarized wave alignment with respect to the base station of the vertically polarized waves is improved.

[0031] On the other hand, second antenna 4 may be longitudinally arranged as shown in Fig. 1D. Thus, second antenna 4 has omnidirectionality in the plane including the longitudinal direction of the casing and the direction normal to the substrate, and the polarization plane becomes parallel to the longitudinal direction of the casing. As a result, when operating a terminal device while looking at a data display portion on the casing or the like, favorable polarized wave alignment is ensured with respect to the base station of the vertically polarized waves regardless of the tilt angle.

[0032] Note that the short-circuit point of second antenna 4 as shown in Fig. 1D may be at any of the upper and lower portions. Further, the shape of second antenna 4 can be arbitrarily selected if it causes a desired electric field in the space between second antenna 4 and substrate 13. Moreover, a plate-like antenna such as a patch antenna can be employed as an internal antenna of the present invention.

[0033] Switch 5 can selectively connect first antenna 3 and second antenna 4 to power supply means 6 through contacts 11a and 11b. Thus, first antenna 3 and second antenna 4 are selectively excited.

[0034] More specifically, referring to Fig. 1C, first antenna 3 and power supply means 6 are connected when pulling out first antenna 3, and second antenna 4 and

power supply means 6 are connected when pushing in first antenna 3. Thus, first antenna 3 is used for communication when it is pulled out, and second antenna is used for communication when first antenna 3 is pushed in.

[0035] As shown in Fig. 1B, first antenna 3 preferably extends in the direction away from human body 7. In this way, the performance degradation of the antenna due to the human body may be alleviated.

Second Embodiment

[0036] Now, referring to Figs. 2A and 2B, the second embodiment of the present invention will be described.

[0037] As shown in Fig. 2A, in the second embodiment, a flip 8 is provided in casing 2 capable of being freely opened and closed, and first antenna 3 is provided in flip 8. The other parts of the structure are the same as in the example shown in Fig. 1A.

[0038] As in the first embodiment, the present embodiment would provide smaller coupling of first and second antennae 3 and 4, whereby the inefficiency problem due to inter-antenna interference can be alleviated.

[0039] First antenna 3 is typically contained in flip 8. For providing first antenna 3 in flip 8, a method disclosed in Japanese Patent Laying-Open No. 8-186518 may be employed.

[0040] Switch 5 connects power supply means 6 to first antenna 3 when flip 8 is opened, and connects power supply means 6 to second antenna 4 when flip 8 is closed. Thus, first antenna 3 is used for communication when flip 8 is opened, and second antenna 4 is used for communication when flip 8 is closed.

[0041] As shown in Fig. 2B, flip 8 preferably extends in the direction away from human body side 7 when flip 8 is opened. Thus, first antenna 3 is held away from the human body.

Third Embodiment

[0042] Now, referring to Figs. 3A and 3B, the third embodiment of the present invention will be described. Fig. 3A shows that first antenna 3 is excited, and Fig. 3B shows that second antenna 4 is excited.

[0043] As shown in Figs. 3A and 3B, in the third embodiment, switches 9 and 10 are provided. When first antenna 3 is pulled out, for example as shown in Fig. 3A, first antenna 3 is excited and second antenna 4 is connected to a load impedance Z2. Thus, the phase of waves reflected by second antenna 4 can be controlled, whereby beam deformation or efficiency decrease of first antenna 3 is suppressed.

[0044] When first antenna 3 is pushed in, for example as shown in Fig. 3B, second antenna 4 is excited and first antenna 3 is connected to load impedance Z1. In this case also, beam deformation or efficiency decrease of second antenna 3 is suppressed.

[0045] Note that the concept of the third embodiment

is applicable to the portable radio shown in Figs. 2A and 2B. In this case, when flip 8 is opened, first antenna 3 is excited and second antenna 4 is connected to load impedance Z2. When flip 8 is closed, second antenna 4 is excited and first antenna 3 is connected to load impedance Z1.

Fourth Embodiment

10 [0046] Now, referring to Figs. 4A and 4B, the fourth embodiment of the present invention will be described.

[0047] As shown in Figs. 4A and 4B, in the fourth embodiment, first antenna 3 has a monopole antenna 3a and a helical antenna 3b. Monopole antenna 3a and helical antenna 3b are arranged in series.

15 [0048] Thus, monopole antenna 3a is used when monopole antenna 3a is pulled out, and helical antenna 3b is used when monopole antenna 3a is pushed in.

[0049] The fourth embodiment produces the same effect as the first embodiment. Further, in the fourth embodiment, second antenna 4 is excited both when monopole antenna 3a is pulled out and pushed in. Accordingly, monopole antenna 3a and second antenna 4 are both excited when monopole antenna 3a is pulled out, and helical antenna 3b and second antenna 4 are both excited when monopole antenna 3a is pushed in.

20 [0050] In the antenna of the present invention, a power supply circuit for exciting two antennae 3 and 4 can be designed as separate from the antenna because of the small coupling of first and second antennae 3 and 4, whereby designing is facilitated. In addition, by simultaneously exciting first and second antennae 3 and 4, the polarized waves are freely changed.

[0051] Here, an excitation method when first and second antennae 3 and 4 are simultaneously excited will be described with reference to Fig. 4A. In Fig. 4A, a power for exciting first antenna 3 is defined as V, and that for exciting second antenna 4 is defined as H.

25 [0052] When a ratio of the above mentioned power levels V and H (V:H) is 1:0, vertically polarized waves can be generated. When V:H is 0.5:0.5, waves polarized by 45° can be generated. When V:H is 0:1, horizontally polarized waves can be generated. Thus, by controlling the ratio of power levels V and H, the polarized waves can be freely changed.

30 [0053] Note that the concept of the fourth embodiment is applicable to the portable radio shown in Figs. 2A and 2B. In this case, first and second antennae 3 and 4 are simultaneously excited both when opening and closing flip 8.

Fifth Embodiment

35 [0054] Now, referring to Figs. 5A and 5B, the fifth embodiment of the present invention will be described.

[0055] As shown in Figs. 5A and 5B, in the fifth embodiment, only first antenna 3 is excited when first antenna 3 is pulled out, and helical antenna 3b and second

antenna 4 are both excited when first antenna 3 is pushed in.

[0056] According to the fifth embodiment, the same effect as in the first embodiment is produced and, when first and second antennae 3 and 4 are excited, the same effect as in the fourth embodiment is produced.

[0057] Note that the concept of the fifth embodiment is applicable to the portable radio shown in Figs. 2A and 2B. In this case, only first antenna 3 is excited when flip 8 is opened, and first and second antennae 3 and 4 are excited when flip 8 is closed.

Sixth Embodiment

[0058] Now, referring to Figs. 6A and 6B, the sixth embodiment of the present invention will be described.

[0059] As shown in Figs. 6A and 6B, in the sixth embodiment, first antenna 3 and second antenna 4 are both excited when first antenna 3 is pulled out, and only second antenna 4 is excited when first antenna 3 is pushed in.

[0060] According to the sixth embodiment, the same effect as in the first embodiment is produced and, when first and second antennae 3 and 4 are simultaneously excited, the same effect as in the fourth embodiment is produced.

[0061] Note that the concept of the sixth embodiment is applicable to the portable radio shown in Figs. 2A and 2B. In this case, first and second antennae 3 and 4 are excited when flip 8 is opened, and only second antenna 4 is excited when flip 8 is closed.

[0062] As in the foregoing, although the embodiments of the present invention have been described, the features of the embodiments can be combined where appropriate. Further, it should be understood that the embodiments herein disclosed is by way of illustration only and is not to be taken by way of limitation. The scope of the present invention is limited only by the terms of the appended claim and may include all variations in the scope equivalent in meaning to the claims.

Industrial Applicability

[0063] The present invention can be effectively applied to a portable radio provided with at least two types of antennae.

Claims

1. A portable radio, comprising:

a casing (2);
a first linear antenna (3) capable of being pulled out from said casing (2);
a second plate-like antenna (4) contained in said casing (2) and connected to a ground substrate (13); and

power supply means (6) for exciting at least one of said first antenna (3) and said second antenna (4).

2. The portable radio according to claim 1, further comprising switching means (5) between said first antenna (3) and said second antenna (4), and said power supply means (6).

3. The portable radio according to claim 2, wherein said switching means (5) connects said first antenna (3) and said power supply means (6) when said first antenna (3) is pulled out, and connects said second antenna (4) and said power supply means (6) when said first antenna (3) is pushed in.

4. The portable radio according to claim 2, wherein said switching means (5) connects both said first antenna (3) and said second antenna (4) to said power supply means (6) when said first antenna (3) is pulled out, and connects said second antenna (4) and said power supply means (6) when said first antenna (3) is pushed in.

5. The portable radio according to claim 2, wherein said switching means (5) connects both said first antenna (3) and said second antenna (4) to said power supply means (6) when said first antenna (3) is pulled out, and also connects both said first antenna (3) and said second antenna (4) when said first antenna (3) is pushed in.

6. The portable radio according to claim 2, wherein said switching means (5) connects said first antenna (3) to said power supply means (6) when said first antenna (3) is pulled out, and connects both said first antenna (3) and said second antenna (4) to said power supply means (6) when said first antenna (3) is pushed in.

7. The portable radio according to claim 1, wherein said first antenna (3) includes a monopole antenna having a length of an integral multiple of a half wave, and said second antenna (4) includes a short patch antenna.

8. The portable radio according to claim 7, wherein said first antenna (3) includes a helical antenna arranged in series with said monopole antenna.

9. The portable radio according to claim 1, wherein said first antenna (3) is obliquely arranged toward a side opposite a human body.

10. A portable radio, comprising:

a casing (2) having a flip (8);
a first antenna (14) provided in said flip (8);

a second plate-like antenna (4) contained in said casing (2) and connected to a ground substrate (13); and
power supply means (6) for exciting at least one of said first antenna (3) and said second antenna (4).

11. The portable radio according to claim 10, further comprising switching means (5) between said first antenna (3) and said second antenna (4), and said power supply means (6).
12. The portable radio according to claim 11, wherein said switching means (5) connects said first antenna (3) to said power supply means (6) when said flip (8) is opened, and connects said second antenna (4) and said power supply means (6) when said flip (8) is dosed.
13. The portable radio according to claim 11, wherein said switching means (5) connects both said first antenna (3) and said second antenna (4) to said power supply means (6) when said flip (8) is opened, and connects said second antenna (4) and said power supply means (6) when said flip (8) is closed.
14. The portable radio according to claim 11, wherein said switching means (5) connects both said first antenna (3) and said second antenna (4) to said power supply means (6) when said flip (8) is opened, and also connects both said first antenna (3) and said second antenna (4) to said power supply means (6) when said flip (8) is closed.
15. The portable radio according to claim 11, wherein said switching means (5) connects said first antenna (3) and said power supply means (6) when said flip (8) is opened, and connects both said first antenna (3) and said second antenna (4) to said power supply means when said flip (8) is closed.

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FIG.1A

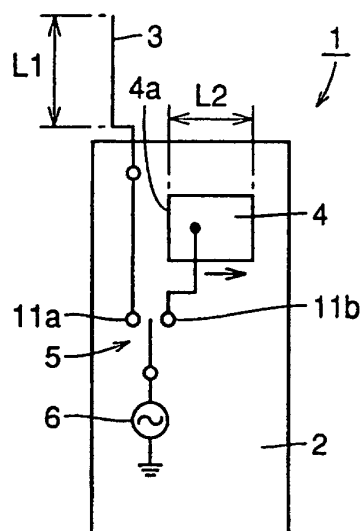


FIG.1B

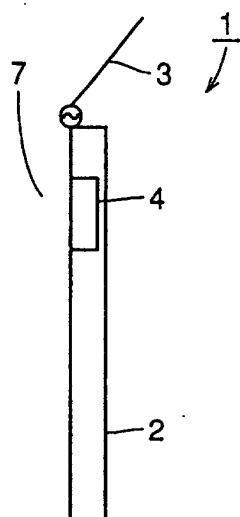


FIG.1C

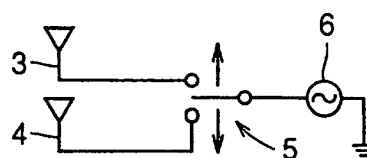


FIG.1D

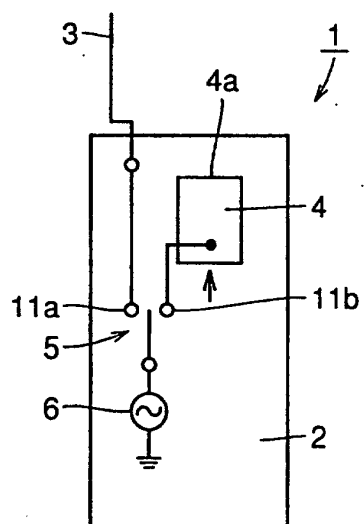


FIG.1E

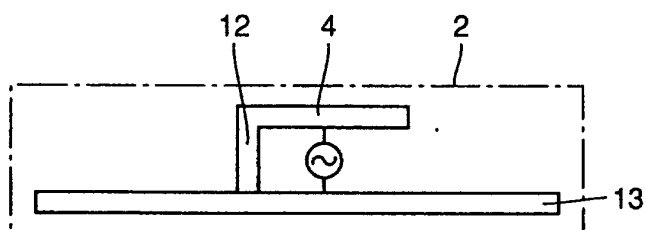


FIG.2A

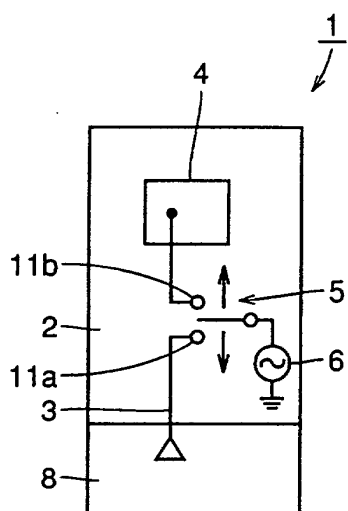


FIG.2B

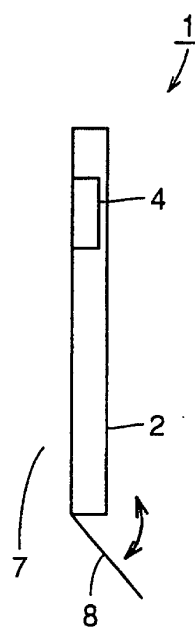


FIG.3A

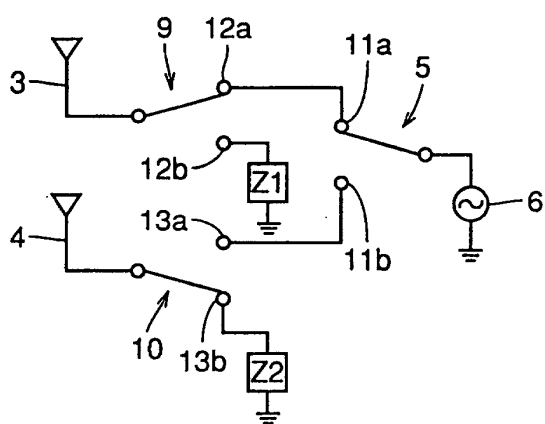


FIG.3B

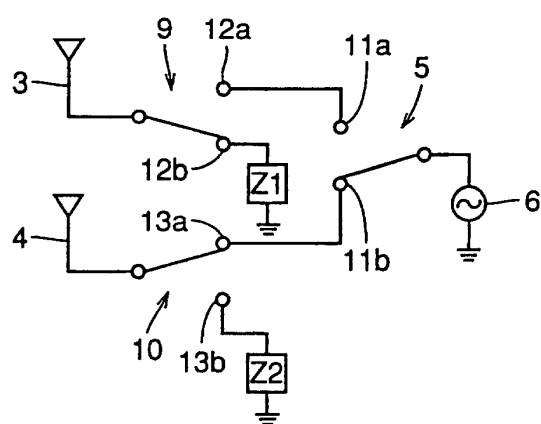


FIG.4A

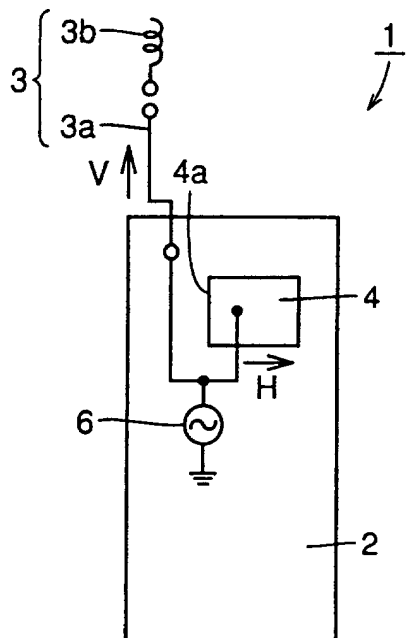


FIG.4B

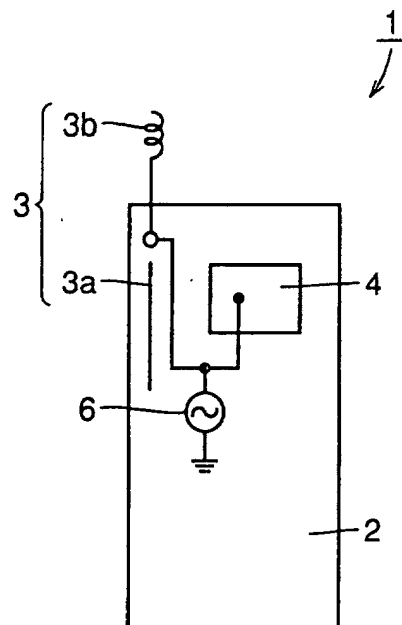


FIG.5A

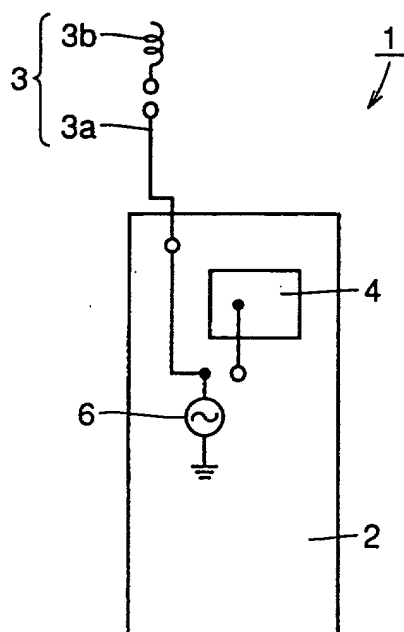


FIG.5B

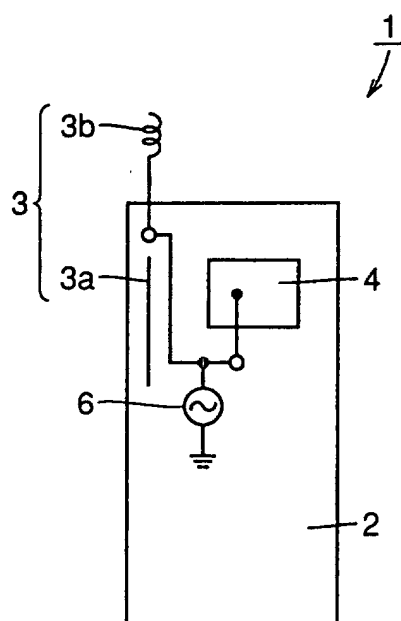


FIG.6A

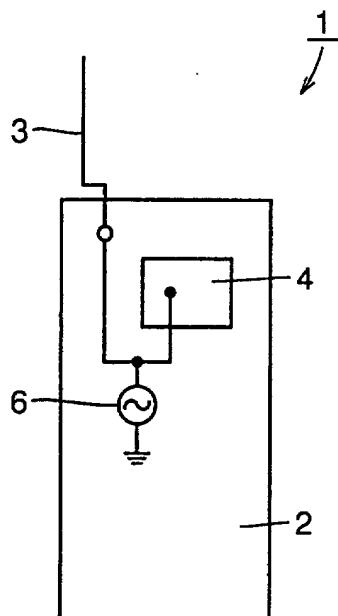


FIG.6B

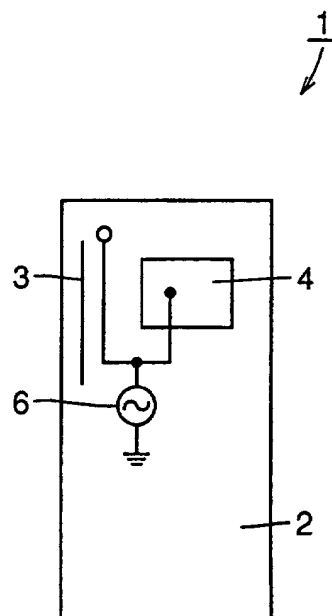
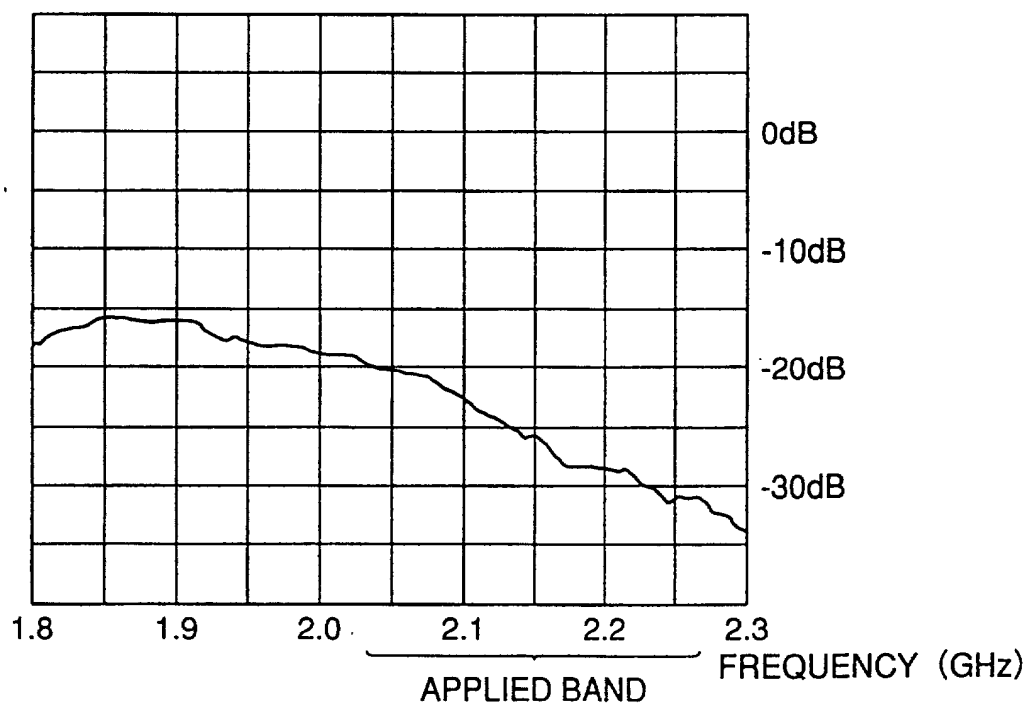


FIG.7



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP00/02607

A. CLASSIFICATION OF SUBJECT MATTER Int.Cl ⁷ H01Q1/24, H04B1/38, H04B7/26, H01Q9/30, H01Q1/08		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) Int.Cl ⁷ H01Q1/00-1/52, H01Q13/00-13/28, H04B7/24-7/26, H04Q7/00-7/04, H04B1/38-1/58		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1922-1996 Toroku Jitsuyo Shinan Koho 1994-2000 Kokai Jitsuyo Shinan Koho 1971-2000 Jitsuyo Shinan Toroku Koho 1996-2000		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	Microfilm of Japanese Utility Model Application No. 128042/1984 (Laid-open No. 042148/1986), (Mitsubishi Electric Corporation), 18 March, 1986 (18.03.86) (Family: none) Full text; Figs. 1-3	1-3, 7, 8 9
X	JP 11-274828 A (Tokin Corporation et al.), 08 October, 1999 (08.10.99) (Family: none) Par. Nos. 13 to 26; Figs. 1 to 4	4
A	JP 09-294103 A (Sony Corporation), 11 November, 1997 (11.11.97) (Family: none) Full text; all drawings	5, 6
Y	CD-ROM of Japanese Utility Model Application No. 055611/1993 (Laid-open No. 025673/1995) (Kyocera Corporation), 12 May, 1995 (12.05.95) (Family: none) Full text; all drawings	9
☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
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Date of the actual completion of the international search 18 July, 2000 (18.07.00)		Date of mailing of the international search report 01 August, 2000 (01.08.00)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
Facsimile No.		Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP00/02607

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	US 005649306 A1 (Motorola, Inc), 15 July, 1997 (15.07.97) & IT, 095730612, A & GB, 002293277, A & FR, 002724773, A & DE, 019533247, A & JP, 08-102609, A & CN, 001123476, A & BR, 009504678, A & CA, 002156967, C Full text, (especially, page 5, lines 48-65), all drawings	10-12 13 14
X	US 5561436 A (Motorola, Inc), 01 October, 1996 (01.10.96) & GB, 002292258, A & FR, 002722919, A & DE, 019526581, A & JP, 08-056109, A & CN, 001122056, A & BR, 009502395, A & US, 005572223, A & CA, 002153541, A & SG, 000052158, A page 5, lines 16 to 35; all drawings	15
A	JP 2000-049649 A (Matsushita Electric Ind. Co., Ltd.), 18 February, 2000 (18.02.00) (Family: none) Full text; all drawings	1-15
A	JP 11-177485 A (NEC Saitama Ltd.), 02 July, 1999 (02.07.99) (Family: none) Full text; all drawings	1-15
A	JP 07-202774 A (Toshiba Corporation), 04 August, 1995 (04.08.95) (Family: none) Full text; all drawings	1-15

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