PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification [6] : H01Q 1/36, 1/38, 9/04, 5/00, 1/24, H04B 1/38 — A1

(11) International Publication Number: WO 99/43043

(43) International Publication Date: 26 August 1999 (26.08.99)

(21) International Application Number: PCT/US99/02470

(22) International Filing Date: 5 February 1999 (05.02.99)

(30) Priority Data:
09/026,456 19 February 1998 (19.02.98) US

(71) Applicant: ERICSSON, INC. [US/US]; 7001 Development Drive, P.O. Box 13969, Research Triangle Park, NC 27709 (US).

(72) Inventor: SPALL, John, M.; 113 Houndschase Run, Cary, NC 27413-3028 (US).

(74) Agents: BODDIE, Needham, J., II et al.; Myers, Bigel, Sibley & Sajovec, P.A., P.O. Box 37428, Raleigh, NC 27627 (US).

(81) Designated States: AL, AM, AT, AT (Utility model), AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, CZ (Utility model), DE, DE (Utility model), DK, DK (Utility model), EE, EE (Utility model), ES, FI, FI (Utility model), GB, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (Utility model), SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

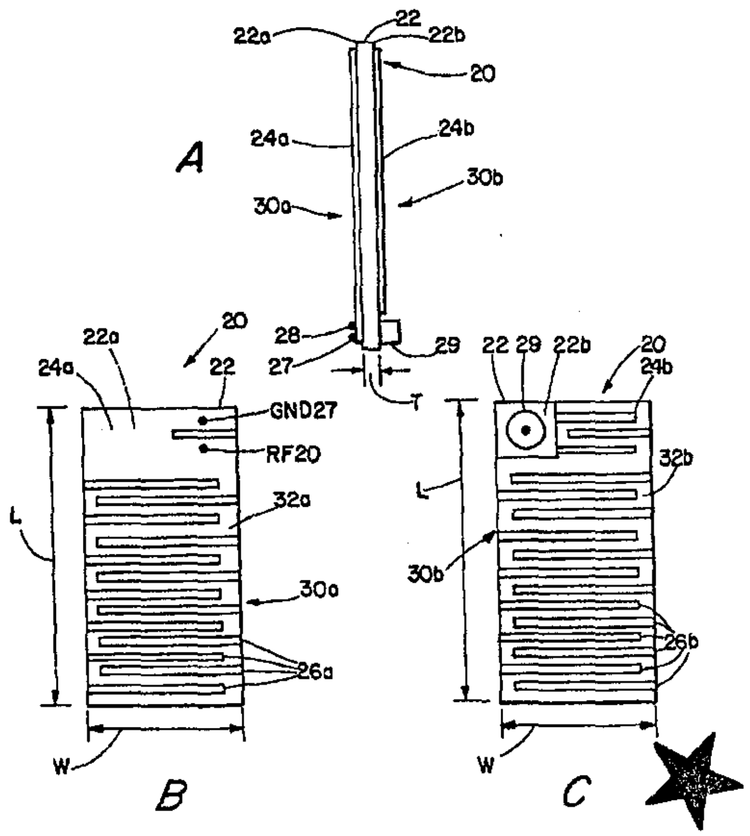
Published
With international search report.

修改页
4000+2000

(54) Title: DUAL BAND DIVERSITY ANTENNA HAVING PARASITIC RADIATING ELEMENT

(57) Abstract

A planar diversity antenna for communications devices, such as radiotelephones, has two radiating elements secured to opposite sides of a dielectric substrate. One radiating element is parasitically coupled to a fed radiating element to resonate at respective adjacent frequency bands. Each radiating element has a meandering electrically conductive path. The planar diversity antenna is maintained in spaced apart, generally parallel relationship with a ground plane within a radiotelephone.



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece			TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	NZ	New Zealand		
CM	Cameroon			PL	Poland		
CN	China	KR	Republic of Korea	PT	Portugal		
CU	Cuba	KZ	Kazakstan	RO	Romania		
CZ	Czech Republic	LC	Saint Lucia	RU	Russian Federation		
DE	Germany	LI	Liechtenstein	SD	Sudan		
DK	Denmark	LK	Sri Lanka	SE	Sweden		
EE	Estonia	LR	Liberia	SG	Singapore		

DUAL BAND DIVERSITY ANTENNA HAVING PARASITIC RADIATING ELEMENT

Field of the Invention

The present invention relates generally to antennas, and more particularly to diversity antennas used within communication devices.

Background of the Invention

Antennas for personal communication devices, such as radiotelephones, may not function adequately when in close proximity to a user during operation, or when a user is moving during operation of a device. Close proximity to objects or movement of a user during operation of a radiotelephone may result in degraded signal quality or fluctuations in signal strength, known as multipath fading. Diversity antennas have been designed to work in conjunction with a radiotelephone's primary antenna to improve signal reception.

Many of the popular hand-held radiotelephones are undergoing miniaturization. Indeed, many of the contemporary models are only 11-12 centimeters in length. Unfortunately, as radiotelephones decrease in size, the amount of internal space therewithin may be reduced correspondingly. A reduced amount of internal space may make it difficult for existing types of diversity antennas to achieve the bandwidth and gain requirements necessary for radiotelephone operation because their size may be correspondingly reduced.

Furthermore, it may be desirable for a diversity antenna to be able to resonate over multiple frequency bands. For example, the Japanese Personal Digital Cellular (PDC) system utilizes two "receive" frequency bands and two "transmit" frequency bands. Accordingly, a diversity antenna within a radiotelephone used in the Japanese PDC system should preferably be able to resonate in each of the two receive frequency bands. Unfortunately, the ability to provide diversity antennas with adequate gain over multiple frequency bands may be presently limited because of size limitations imposed by radiotelephone miniaturization.

Summary of the Invention

It is, therefore, an object of the present invention to provide diversity antennas that can resonate over multiple frequency bands with sufficient gain for use within personal communication devices such as radiotelephones.

It is also an object of the present invention to provide reduced size diversity antennas that can resonate over multiple frequency bands with sufficient gain and that can be installed within the small internal space of miniature radiotelephones.

These and other objects of the present

invention are provided by a planar diversity antenna for communications devices, such as radiotelephones, having two radiating elements secured to opposite sides of a dielectric substrate and parasitically coupled to jointly resonate at two adjacent frequency bands. One radiating element, referred to as the "fed" radiating element, has a meandering electrically conductive path with an RF feed point and a ground point thereon. A second radiating element, referred to as the "parasitic" radiating element, has a meandering electrically conductive path thereon. The parasitic radiating element is maintained in a spaced-apart, generally parallel relationship with both the "fed" radiating element and a ground plane.

When a planar diversity antenna according to the present invention is used within a radiotelephone, a shield can overlying the RF circuitry may serve as a ground plane. The planar antenna element is secured within the housing of a radiotelephone such that the parasitic radiating element is in spaced apart parallel relationship with an outer planar surface of the shield can. An aperture in the shield can outer surface allows a hot feed element to extend from the RF circuitry through the shield can aperture and electrically connect with the feed point on the fed radiating element conductive path. A ground feed element electrically connects the ground post on the fed radiating element conductive path with the grounded shield can.

The fed and parasitic radiating elements may have meandering electrically conductive paths with different electrical and physical lengths. Accordingly, the fed and parasitic radiating elements jointly radiate in dual-band resonances. Exemplary adjacent frequency bands include from between 0.810 and 0.828 GHz and between 0.870 and 0.885 GHz.

Diversity antennas according to the present invention may be advantageous because their configuration can allow them to conform to the small space constraints of current radiotelephones and other communication devices while providing adequate gain and bandwidth characteristics. The dual band functionality of diversity antennas incorporating aspects of the present invention may be particularly advantageous in countries, such as Japan, which utilize multiple frequency bands for transmitting and receiving radiotelephone communications. The present invention may be suitable as a diversity antenna for a dual band radiotelephone.

Brief Description of the Drawings

Fig. 1 illustrates a planar inverted F antenna used within radiotelephones.

Figs. 2A-2C illustrate a dual band diversity antenna having a fed radiating element and a parasitic radiating element, according to the present invention.

Fig. 3 is an exemplary resonance curve achievable by a dual band diversity antenna incorporating aspects of the present invention.

Fig. 4 illustrates a dual band diversity antenna, according to the present invention, secured to a shield can of a radiotelephone.

Detailed Description of the Invention

The present invention now will be described more fully hereinafter with reference to the accompanying drawings, in which preferred embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Like numbers refer to like elements throughout.

As is known to those skilled in the art, an antenna is a device for transmitting and/or receiving electrical signals. A transmitting antenna typically includes a feed assembly that induces or illuminates an aperture or reflecting surface to radiate an electromagnetic field. A receiving antenna typically includes an aperture or surface focusing an incident radiation field to a collecting feed, producing an electronic signal proportional to the incident radiation. The amount of power radiated from or received by an antenna depends on its aperture area and is described in terms of gain. Radiation patterns for antennas are often plotted using polar coordinates. Voltage Standing Wave Ratio (VSWR) relates to the impedance match of an antenna feed point with the feed line or transmission line. To radiate RF energy with minimum loss, or to pass along received RF energy to the receiver with minimum loss, the impedance of the antenna should be matched to the impedance of the transmission line or feeder.

Radiotelephones typically employ a primary antenna which is electrically connected to a transceiver operably associated with a signal processing circuit positioned on an internally disposed printed circuit board. In order to maximize power transfer between the antenna and the transceiver, the transceiver and the antenna are preferably interconnected such that the respective impedances are substantially "matched," *i.e.*, electrically tuned to filter out or compensate for undesired antenna impedance components to provide a 50 Ohm (or desired) impedance value at the circuit feed.

As is well known to those skilled in the art, a diversity antenna may be utilized in conjunction with a primary antenna within a radiotelephone to prevent calls from being dropped due to fluctuations in signal strength. Signal strength may vary as a result of a user moving between cells in a cellular telephone network, a user walking between buildings, interference from stationary objects, and the like. Diversity antennas are designed to pick up signals that the main antenna is unable to pick up through spatial, pattern, and bandwidth or gain diversity. Diversity antennas may also be utilized to offset Rayleigh fading, which may include sudden deep fades or losses of signal strength due to multipath phase cancellation.

A type of diversity antenna well known in the art is the Planar Inverted F Antenna (PIFA) and is illustrated in **Fig. 1**. The illustrated PIFA **10** includes a radiating element **12** maintained in spaced apart relationship with a ground plane **14**. The radiating element is also grounded to the ground plane **14** as indicated by **16**. A hot RF connection **17** extends from underlying circuitry (not shown) through the ground plane **14** to the radiating element **12** at **18**. A PIFA is tuned to desired frequencies by adjusting the following parameters which can affect gain and bandwidth: varying the length **L** of the radiating element **12**; varying the gap **H** between the radiating element **12** and the ground plane **14**; and varying the distance **D** between the ground and hot RF connections. Ground plane size may also be an important tuning parameter. Other parameters known to those skilled in the art may be adjusted to tune the PIFA, and will not be discussed further.

Referring now to **Figs. 2A-2C** a dual band diversity antenna **20** in accordance with a preferred embodiment of the present invention is illustrated. The antenna **20** includes a dielectric substrate **22**, such as a fiberglass circuit board, having first and second opposite surfaces **22a** and **22b**. A particularly preferable material for use as the substrate is an FR4 board which is well known to those having skill in the art of circuit boards. However, various dielectric materials may be utilized for the substrate **22**.

Preferably, the dielectric substrate **22** has a dielectric constant between 4.4 and 4.8 for the illustrated embodiment. However, it is to be understood that dielectric substrates having different dielectric constants may be utilized without departing from the spirit and intent of the present invention.

Diversity antennas, according to the present invention, are particularly well suited for combating both Rayleigh (line of sight and one main reflection) and Ricean (multiple reflections) fading. The present invention allows the diversity antenna to reside in a very small mobile radiotelephone and helps when the main antenna enters into a very large fade region.

Dimensions of the dielectric substrate **22** may vary depending on the space limitations of the radiotelephone or other communications device within which the diversity antenna **20** is incorporated. Typically, the dielectric substrate **22** will have a thickness **T** of between 1.0 and 1.5 millimeters (mm); a width **W** of between 11 and 22 mm; and a length **L** of between 21 and 23 mm.

A layer of copper or other conductive material is secured to both the first and second substrate surfaces **22a** and **22b**, and is indicated as **24a** and **24b**, respectively. A preferred conductive material is copper tape because portions thereof can be removed easily during tuning of the antenna. Typically, the thickness of the conductive layers **24a**, **24b** on each respective substrate surface **22a**, **22b** is between 0.5 ounces (oz) and 1.0 oz copper.

A ground post **27** and a hot RF feed point **28** are electrically connected to the conductive layer **24a**, as illustrated in **Fig. 2B**. The locations of the ground post **27** and the hot RF feed point **28** on the substrate first surface conductive layer **24a** are selected based upon desired input impedance. A coaxial connector **29** extends through, but is not electrically connected to, the substrate second surface conductive layer **24b**, as illustrated in **Fig. 2C**. The ground post **27** and the hot RF feed point **28** are electrically connected to underlying circuitry (not shown) within a radiotelephone via the coaxial connector **29**, as will be described below.

The conductive layer **24b** secured to the substrate second surface **22b** is a parasitic conductive layer; *i.e.*, it is not electrically connected to other portions of the antenna **20**. As is known to those skilled in the art, parasitic electromagnetic elements are coupled to, and "feed off", near-field currents (i.e., currents flowing on a conductive surface exist in a "field" of electromagnetic fields that the currents induce in close proximity to the conductive surface). A parasitic antenna is an antenna that is not driven directly by an RF source, but rather, is excited by energy radiated by another source. The presence of a parasitic element may change the resonant characteristics of a nearby antenna, allowing the antenna to resonate in more than one band.

As will be described below, the first and second substrate surfaces **22a**, **22b** and the respective conductive layers **24a**, **24b** thereon each function as respective radiating elements, indicated as **30a** and **30b**. Radiating element **30a** is referred to as a "fed" radiating element, and radiating element **30b** is referred to as a "parasitic" radiating element. As will be described below, the fed and parasitic radiating elements **30a**, **30b** allow the antenna **20** to be tuned so as to resonate within at least two frequency bands.

Referring to **Figs 2B** and **2C**, portions **26a**, **26b** of each conductive layer **24a**, **24b** respectively, have been removed to create meandering electrically conductive patterns for radiating RF energy, indicated as **32a** and **32b**, respectively. The length of each meandering electrically conductive pattern **32a**, **32b** is a tuning parameter, as is known to those skilled in the art. The fed radiating element **30a** and the parasitic radiating element **30b** allow the antenna **20** to resonate within at least two frequency bands. The parasitic radiating element **30b** is excited by magnetic fields generated from the fed radiating element **30a**. The fed radiating element **30a** and the parasitic radiating element **30b** are preferably configured to produce two different resonant frequencies. Accordingly, the bandwidth of the antenna may be increased compared with an antenna having only a single radiating element.

Referring now to **Fig. 3**, an exemplary resonance curve **40** achievable by a dual band diversity antenna, according to the present invention, is illustrated. VSWR is plotted along the "Y" axis and is indicated as **42**. Frequency is plotted along the "X" axis and is indicated as **44**. As shown by the illustrated resonance curve **40**, the fed radiating element **30a** and the parasitic radiating element **30b** are configured to resonate at two closely spaced receive bands (Band 1) and (Band 2). Band 1 extends from frequency f_1 to frequency f_2, and Band 2 extends from frequency f_3 to frequency f_4. Band 1 and Band 2 are closely spaced and each is below the 2:1 VSWR to facilitate impedance matching. The resonance curve **40** shows where (in frequency) the match between the antenna and the receiver circuit will result in 0.5dB or less of loss. The represented a dual band diversity antenna is made to approach a ¼-¼ wave retractable antenna in gain over the two frequency bands. As is understood by those skilled in the art, the resonance curve **40** is adjustable by "tuning" the antenna **20**. Tuning includes adjusting and selecting various parameters of the dual band diversity antenna as described below.

Referring now to **Fig. 4**, a dual band diversity antenna **20**, according to the present invention, is illustrated in an installed configuration within a communications device, such as a radiotelephone. The antenna **20** overlies, and is maintained in spaced apart relationship with, a shield can **52**. The shield can **52** overlies a circuit board **54** and provides electromagnetic interference (EMI) shielding for various microelectronic components (not shown) secured to the circuit board. The shield can **52** has a planar outer surface 53 which serves as a ground plane for the antenna 20.

In the illustrated embodiment, a coaxial connector 29 provides a pathway for a hot feed element 33 to extend from the circuit board 54 through the shield can aperture 31 and electrically connect with the feed point 28. The illustrated coaxial connector 29 also provides a pathway for a ground feed element 35 to electrically connect the ground post 27 with the grounded shield can 52. As is known to those skilled in the art, the hot feed element 33 electrically connects the hot RF feed point 28 with a receiver input and output (not shown), preferably via an RF switch (receive only) (not shown), on the underlying circuit board 54. The RF switch switches out the primary and diversity antennas to the receiver.

The parasitic radiating element 30b of the antenna 20 is maintained in spaced apart generally parallel relationship with the outer surface 53 of the shield can 52. Foam 55 or other similar non-conductive material is preferably placed between the parasitic radiating element 30b and the outer surface 53 of the shield can 52 and serves as means for reducing the effects of vibrations and jarring.

Tuning parameters for the illustrated diversity antenna 20 include, but are not limited to: the length L of the antenna 20; the thickness D_1 of the dielectric substrate 22; the distance D_2 between the shield can 52 and the antenna 20; the distance D_3 between the hot RF feed point 28 and the ground post

27; and the length of the meandering electrically conductive patterns of both the fed radiating element **30a** and the parasitic radiating element **30b**. The dielectric substrate 22 and length of the meandering electrically conductive patterns define "electrical length" necessary to radiate a resonance structure. Ground plane, feeds and feed separation are variations of the classical antenna.

The foregoing is illustrative of the present invention and is not to be construed as limiting thereof. Although a few exemplary embodiments of this invention have been described, those skilled in the art will readily appreciate that many modifications are possible in the exemplary embodiments without materially departing from the novel teachings and advantages of this invention. Accordingly, all such modifications are intended to be included within the scope of this invention as defined in the claims. In the claims, means-plus-function clauses are intended to cover the structures described herein as performing the recited function and not only structural equivalents but also equivalent structures. Therefore, it is to be understood that the foregoing is illustrative of the present invention and is not to be construed as limited to the specific embodiments disclosed, and that modifications to the disclosed embodiments, as well as other embodiments, are intended to be included within the scope of the appended claims. The invention is defined by the following claims, with equivalents of the claims to be included therein.

THAT WHICH IS CLAIMED IS:

1. An antenna, comprising:

a dielectric substrate comprising opposite first and second faces;

a first radiating element disposed on said dielectric substrate first face, said first radiating element comprising a first meandering electrically conductive path; and

a second radiating element disposed on said dielectric substrate second face and parasitically coupled with said first radiating element, said second radiating element comprising a second meandering electrically conductive path.

2. An antenna according to Claim 1 wherein said first and second meandering electrically conductive paths have different lengths.

3. An antenna according to Claim 1 wherein said first meandering electrically conductive path includes an RF feed point.

4. An antenna according to Claim 1 wherein said first meandering electrically conductive path includes a ground post.

5. An antenna according to Claim 1 wherein said dielectric substrate has a dielectric constant between 4.4 and 4.8.

6. An antenna according to Claim 1 further comprising a hot feed element extending through said dielectric substrate and electrically connected to said feed point.

7. An antenna according to Claim 1 further comprising a ground feed element extending through said dielectric substrate and electrically connected to said ground post.

8. An antenna according to Claim 1 wherein said first and second radiating elements jointly resonate within adjacent frequency bands.

9. An antenna according to Claim 8 wherein said adjacent frequency bands are between 0.810 and 0.828 GHz and between 0.870 and 0.885 GHz, respectively.

10. An antenna assembly for a communications device, said antenna assembly comprising:

a ground plane having an aperture therethrough;

a planar antenna in adjacent parallel spaced apart relationship with said ground plane, and wherein said antenna comprises:

a dielectric substrate comprising opposite first and second faces;

a first radiating element disposed on said substrate first face, said first radiating element comprising a first meandering electrically conductive path having an RF feed point and a ground point; and

a second radiating element disposed on said substrate second face and parasitically coupled with said first radiating element, said second radiating element comprising a second meandering electrically conductive path;

a hot feed element extending through said ground plane aperture and electrically connected to said feed point; and

a ground feed element extending from said ground plane and electrically connected to said ground post.

11. An antenna assembly according to Claim 10 wherein said first and second meandering electrically conductive paths have different lengths.

12. An antenna assembly according to Claim 10 wherein said dielectric substrate has a dielectric constant between 4.4 and 4.8.

13. An antenna assembly according to Claim 10 wherein a hot feed element extends through said dielectric substrate.

14. An antenna assembly according to Claim 10 wherein a ground feed element extends through said dielectric substrate.

15. An antenna assembly according to Claim 10 wherein said first and second radiating elements jointly resonate within adjacent frequency bands.

16. An antenna assembly according to Claim 15 wherein said adjacent frequency bands are between 0.810 and 0.828 GHz and between 0.870 and 0.885 GHz, respectively.

17. A radiotelephone apparatus, comprising:

a housing;

a circuit board disposed within said housing and having a face with electronic components mounted thereon;

a shield can overlying and secured to a portion of said circuit board face, said shield can having a planar outer surface with an aperture formed therethrough;

a planar antenna overlying said shield can outer surface and comprising:

a dielectric substrate comprising opposite first and second faces;

a first radiating element disposed on said substrate first face, said first radiating element comprising a first meandering electrically conductive path having an RF feed point and a ground point; and

a second radiating element disposed on said substrate second face and parasitically coupled with said first radiating element, said second radiating element comprising a second meandering electrically conductive path;

wherein said planar antenna element is secured within said housing such that said second radiating element is in spaced apart parallel relationship with said shield can outer surface;

a hot feed element extending from said circuit board through said shield can aperture and electrically connecting said feed point; and

a ground feed element extending from said shield can and electrically connecting said ground post.

18. A radiotelephone apparatus according to Claim 17 further comprising means for reducing vibrations, said means positioned between said second radiating element and said shield can outer surface.

19. A radiotelephone apparatus according to Claim 17 wherein said first and second meandering electrically conductive paths have different lengths.

20. A radiotelephone apparatus according to Claim 17 wherein said dielectric substrate has a dielectric constant between 4.4 and 4.8.

21. A radiotelephone apparatus according to Claim 17 wherein said hot feed element extends through said dielectric substrate.

22. A radiotelephone apparatus according to Claim 17 wherein said ground feed element extends through said dielectric substrate.

23. A radiotelephone apparatus according to Claim 17 wherein said first and second radiating elements jointly resonate within adjacent frequency bands.

24. A radiotelephone apparatus according to Claim 23 wherein said adjacent frequency bands are between 0.810 and 0.828 GHz and between 0.870 and 0.885 GHz, respectively.

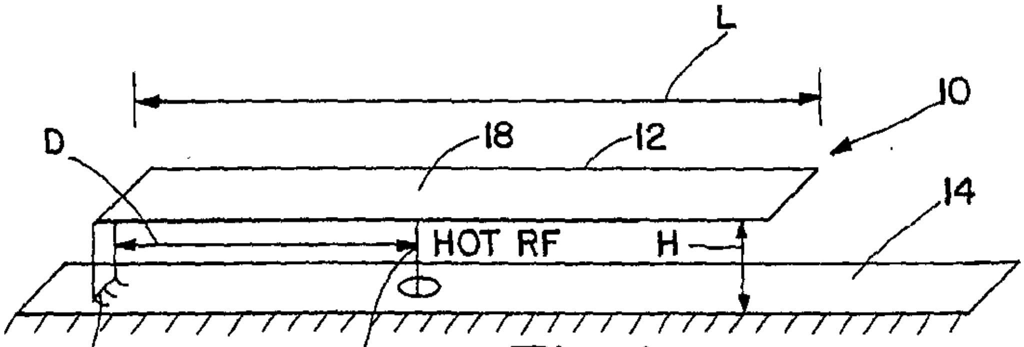


Fig. 1
(PRIOR ART)

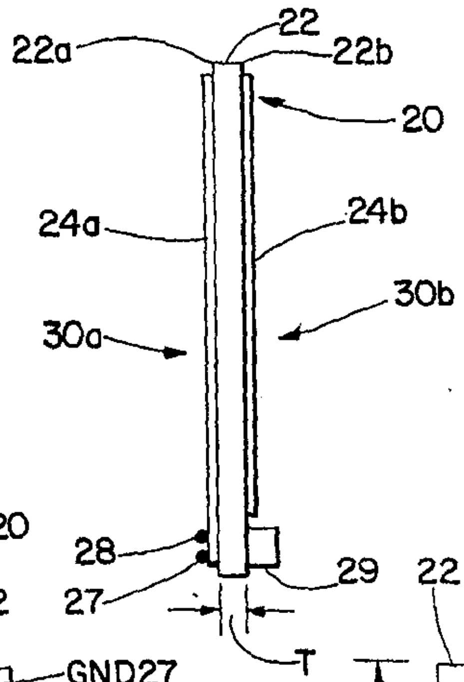


Fig. 2A

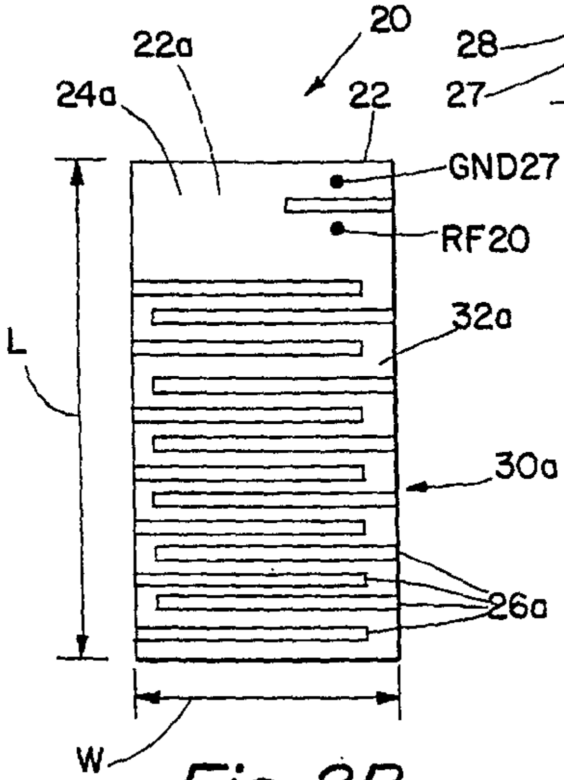


Fig. 2B

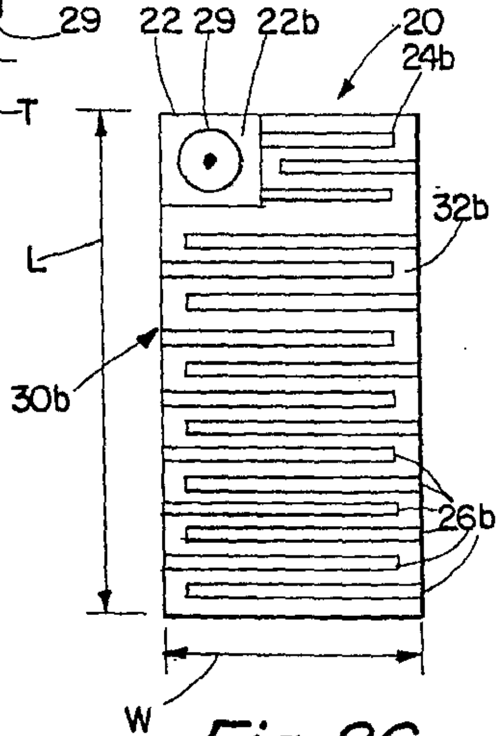


Fig. 2C

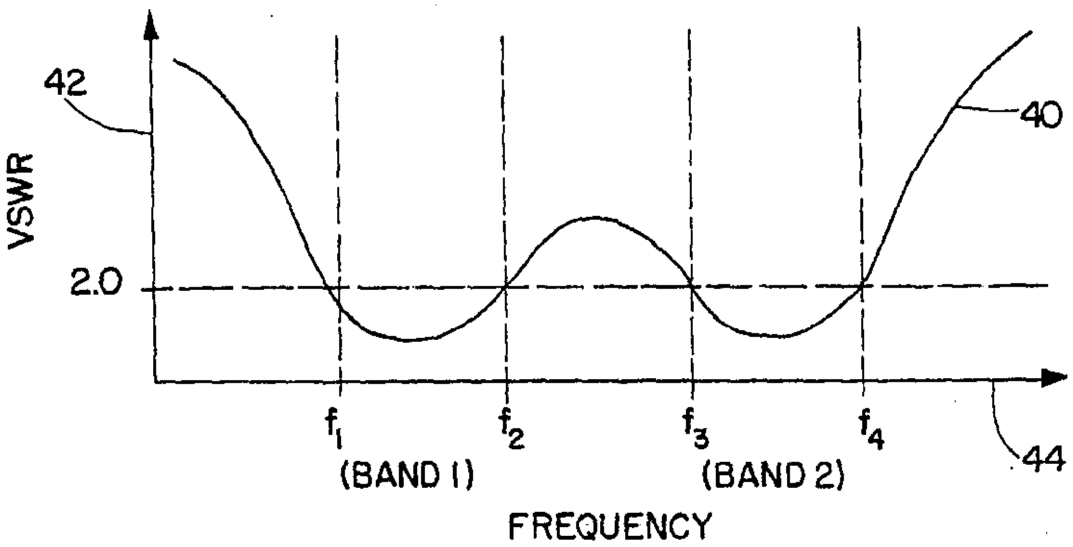

42
VSWR
2.0
40
f_1
f_2
f_3
f_4
(BAND 1)
(BAND 2)
44
FREQUENCY

Fig. 3

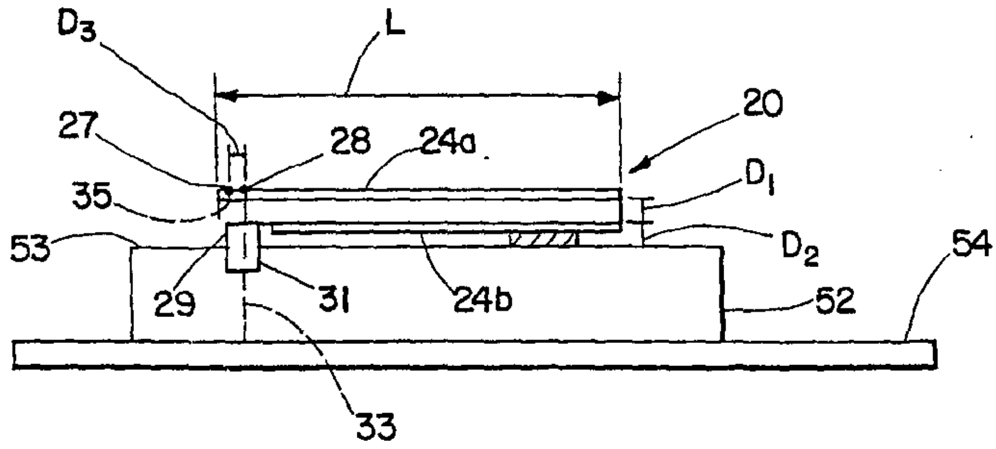

D3
L
27
28
24a
20
35
D1
53
D2
54
29
31
24b
52
33

Fig. 4

[19]中华人民共和国国家知识产权局

[51]Int. Cl⁷

H01Q 1/36
H01Q 1/38 H01Q 9/04
H01Q 5/00 H01Q 1/24
H04B 1/38

[12]发明专利申请公开说明书

[21]申请号 99803083.X

[43]公开日 2001年4月11日

[11]公开号 CN 1291363A

[22]申请日 1999.2.5 [21]申请号 99803083.X

[30]优先权

[32]1998.2.19 [33]US [31]09/026,456

[86]国际申请 PCT/US99/02470 1999.2.5

[87]国际公布 WO99/43043 英 1999.8.26

[85]进入国家阶段日期 2000.8.18

[71]申请人 艾利森公司

地址 美国北卡罗莱纳州

[72]发明人 J·M·斯帕尔

[74]专利代理机构 中国专利代理(香港)有限公司

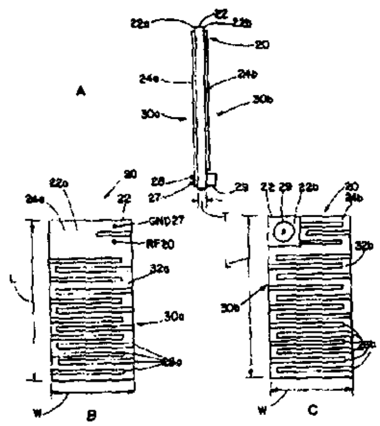
代理人 王 勇 陈景峻

权利要求书3页 说明书6页 附图页数2页

[54]发明名称 具有无源辐射元件的双频带分集天线

[57]摘要

一种用于例如无线电话机这样的通信设备的平面分集天线具有两个固定在一介质基片相对边的辐射元件。一个辐射元件无源地耦合到馈电辐射元件,以便在各自相邻的频段谐振。每个辐射元件具有弯曲的导电路径。平面分集天线保持空间上分开,通常与无线电话机中的接地平面保持平行关系。



ISSN1008-4274

知识产权出版社出版

权　利　要　求　书

1. 一种天线，包括：

一介质基片，包括相对的第一和第二面；

一第一辐射元件，配置在所说介质基片第一面上，所说第一辐射元件包括第一弯曲导电路径；以及

一第二辐射元件，配置在所说介质基片第二面上，并无源地同所说第一辐射元件耦合，所说第二辐射元件包括第二弯曲导电路径。

2. 按权利要求 1 的天线，其中所说第一和第二弯曲导电路径具有不同长度。

3. 按权利要求 1 的天线，其中所说第一弯曲导电路径包括一个 RF 馈电点。

4. 按权利要求 1 的天线，其中所说第一弯曲导电路径包括一个接地接线柱。

5. 按权利要求 1 的天线，其中所说介质基片具有 4.4 和 4.8 之间的一个介电常数。

6. 按权利要求 1 的天线还包括通过所说介质基片延伸并电连接到所说馈电点的一个带电馈电元件。

7. 按权利要求 1 的天线还包括通过所说介质基片延伸并连接到所说接地接线柱的一个接地馈电元件。

8. 按权利要求 1 的天线，其中所说第一和第二辐射元件联合地谐振在相邻的频带内。

9. 按权利要求 8 的天线，其中所说相邻的频带分别在 0.810 和 0.828GHz 之间以及 0.870 和 0.885GHz 之内。

10. 一种用于通信设备的天线部件，所说天线部件包括：

具有一个通孔的接地平面；

一个平面天线，同所说接地平面成相邻平行间距关系，其中所说天线包括：

一介质基片，包括相对的第一和第二面；

一第一辐射元件，配置在所说基片第一面上，所说第一辐射元件包括第一弯曲导电路径，该路径具有一个 RF 馈电点和一个接地点；以及

一第二辐射元件，配置在所说基片第二面上并无源地同所说第一

辐射元件耦合，所说第二辐射元件包括第二弯曲导电路径；

一带电馈电元件通过所说接地平面孔延伸并由连接到所说馈电点；以及

一接地馈电元件从所说接地平面延伸并电连接到所说接地接线柱.

11.按权利要求 10 的天线部件，其中所说第一和第二弯曲导电路径具有不同的长度.

12.按权利要求 10 的天线部件，其中所说介质基片的介电常数在 4.4 和 4.8 之间.

13.按权利要求 10 的天线部件，其中一个带电馈电元件通过所说介质基片延伸.

14.按权利要求 10 的天线部件，其中接地馈电元件通过所说的介质基片延伸.

15.按权利要求 10 的天线部件，其中所说第一和第二辐射单元联合谐振在相邻频带.

16.按权利要求 15 的天线部件，其中所说相邻频带分别在 0.810 和 0.828GHz 之间以及 0.870 和 0.885GHz 之间.

17.一种无线电话设备，包括：

一个外壳；

一个电路板，配置在所说外壳内并有一个面，在其上面安装电子元件；

一个屏蔽罩，覆盖并固定到所说电路板面的一部分，所说屏蔽罩有一个平的外表面以及形成的通孔；

一个平面天线覆盖所说屏蔽罩外表面并包括：

一个介质基片，包括相对的第一和第二面；

一个第一辐射元件，配置在所说基片第一面上，所说第一辐射元件包括具有一 RF 馈电点和一接地点的第一弯曲导电路径；以及

一个第二辐射元件，配置在所说基片第二面上，并无源地同所说第一辐射元件耦合，所说第二辐射元件包括一第二弯曲导电路径；

其中所说平面天线元件固定在所说外壳内，使得所说第二辐射元件同所说屏蔽罩外表面成间隔平行关系；

一个带电馈电元件，从所说电路板通过所说屏蔽罩孔延伸并电连

接所说馈电点；以及

一个接地馈电元件，从所说屏蔽罩延伸并电连接所说接地接线柱.

18.按权利要求 17 的无线电话机设备还包括用于减小振动的装置，所说装置放置在所说第二辐射元件和所说屏蔽罩外表面之间.

19.按权利要求 17 的天线电话设备，其中所说第一和第二弯曲导电路径具有不同的长度.

20.按权利要求 17 的无线电话设备，其中所说介质基片的介电常数在 4,4 和 4,8 之间.

21.按权利要求 17 的天线电话设备，其中所说带电馈电元件通过所说介质基片延伸.

22.按权利要求 17 的无线电话设备，其中所说接地馈电元件通过所说介质基片延伸.

23.按权利要求 17 的无线电话设备，其中所说第一和第二辐射元件联合地谐振在相邻的频带内.

24.按权利要求 23 的无线电话设备，其中所说相邻频带分别在 0.810 和 0.828GHz 之间以及 0.870 和 0.885GHz 之间.

说 明 书

具有无源辐射元件的双频带分集天线

发明领域

本发明一般涉及天线，特别涉及用在通信设备中的分集天线.

发明背景

用于个人通信设备例如无线电话机的天线在当工作时紧靠用户，或当设备操作时用户正在移动时可不起合适的作用. 在操作无线电话机期间天线紧靠物体或用户移动可以导至信号质量的降低或信号强度的涨落，而此为熟悉的多路径衰减. 已设计了分集天线，它同无线电话机的主天线组合在一起工作，从而改善了信号的接收.

许多受欢迎的手持无线电话机正进行小型化. 的确，许多现代型的仅 11－12 厘米长. 不幸的是，当减小无线电话机尺寸时，其内部空间相应减小. 内部空间的减小很难使现存分集天线达到对无线电话机工作必需的带宽和增益要求，因为它们的尺寸可相应地减小.

有幸地，可考虑一种分集天线能在多个频带上谐振. 例如，日本个人数字蜂窝（PDC）系统使用两个“接收”频带和两个“发射”频带. 因此，在日本 PDC 系统中使用的无线电话机中的一个分集天线最好应当能在两个接收频带的每一个中谐振. 不幸地，在多个频带上提供具有适当增益的分集天线的能力目前受到限制，这是由于无线电话机小型化强加的尺寸限制所导致.

发明概要

因此，本发明的一个目的在于提供能在多频带上谐振并且有足够增益的分集天线，用在例如无线电话机这样的个人通信设备中.

本发明的再一目的在于提供能在多频带上谐振并具有足够增益的尺寸减小的分集天线，并能安装在小型无线电话机的小的内部空间中.

本发明的这些和其他目的由用于例如无线电话机这样的通信设备的平面分集天线提供，该天线具有两个固定在一介质基片相对边的辐射元件并无源地耦合，以便在两个相邻频带上联合地谐振. 一个辐射元件被称作“馈电”辐射元件，其上具有弯曲导电路径，以及一个 RF 馈电点和接地点. 第二辐射元件被称作“无源”辐射元件，其上具有

弯曲导电路径．无源辐射元件同“馈电”辐射元件和接地平面两者保持间隔，通常是平行关系．

当按本发明的一种平面分集天线用在无线电话机中时，覆盖 RF 电路的屏蔽罩可用作接地平面．平面天线元件固定在无线电话机的外壳中，使得无源辐射元件与该屏蔽罩的外平表面成间隔平行关系，在屏蔽罩外表面中的一个孔允许一带电馈电元件通过该屏蔽罩孔从 RF 电路延伸并与馈电辐射元件导电路径上的馈电点电连接．一个接地馈电元件将馈电辐射元件导电路径上的接地接线柱同接地的屏蔽罩电连接．

馈电和无源辐射元件可具有以不同电的和物理的长度的弯曲的导电路径．因此馈电和无源辐射元件的双频带谐振联合地辐射．示例性相邻频带包括在 0.810 和 0.828GHz 和在 0.870 和 0.885GHz 之间．

按本发明的分集天线可以是有利的，因为它们的造型能使它们符合目前无线电话机和其他通信设备的小的空间限制，同时提供了适度的增益和带宽特性．在许多国家，例如日本，包括本发明多个方面的分集天线的双频带功能度可以是特别有有利的，其使用多频带来发射和接收无线电话通信．本发明可适合用作双频带天线电话机的分集天线．

附图简述

图 1 说明使用在无线电话机中的一个平面倒 F 天线（Plannar Inverted F Antenna）．

图 2A－2C 说明按本发明的具有一个馈电辐射元件和一个无源辐射元件的双频带分集天线．

图 3 为由包括本发明多个方面的双频带分集天线得到的一个示例性谐振曲线．

图 4 说明固定到无线电话机屏蔽罩的按本发明的一个双频带分集天线．

本发明的详细说明

以下将参照附图更充分地描述本发明，其中表示本发明的优选实施例．然而本发明可以用许多不同的方式实施并不应当认作限制在这里说明的实施例；另外，所提供的这些实施例使公开彻底并完全，并且对那些本专业技术人员而言这种公开将完全覆盖本发明的范围．在所有附图中相同数字标记表示相同元件．

如本专业技术人员所了解的，天线是用来发射和/或接收电信号的设备。一个发射天线一般包括一个馈电部件，其感生成辐射一个孔径或反射表面以辐射电磁场。一个接收天线一般包括聚焦输入辐射场到一收集馈电器的孔径或表面，以产生正比于输入辐射的电信号。从天线辐射的或由天线接收的功率取决于天线的孔径面积并用术语增益加以描述。天线的辐射图通常用极坐标描绘。电压驻波比（VSWP）与天线馈电点同馈电线或传输线的阻抗匹配相关。为以最小损耗辐射 RF 能量，或以最小损耗将接收的 RF 能量传送到接收机，天线的阻抗应当与传输线或馈电器的阻抗相匹配。

无线电话机一般使用一个主天线，其工作时电连接到与放置在内置印刷电路板上的信号处理电路相关的收发信机。为使在天线和收发信机之间传送的功率最大，收发信机和天线互连最好使得各自的阻抗基本“匹配”，即，在电路馈电处为滤除或补偿不需要的天线阻抗分量以提供 50 欧姆（或需要的）阻抗值而进行电调谐。

如那些本专业技术人员所了解的，可以用一个分集天线与无线电话机内的一个主天线组合以防止呼叫由于信号强度的涨落而衰减。信号强度可以因用户在蜂窝电话网络的网孔之间的移动，用户在建筑物之间移动，来自静物的干扰等原因而变化。分集天线被设计来拾取主天线不能通过空间，方向图，以及带宽或增益分集拾取的信号。分集天线还可以用来补偿雷利（RayLeigh）衰减，其可以包括因多路径相位抵消信号强度非常突然的衰落或损失。

技术中熟悉的一种类型的分集天线是平面倒 F 天线（PIFA）并在图 1 中说明。所说明的 PIFA10 包括辐射元件 12，它与接地平面 14 保持空间相隔关系。该辐射单元还被接地到接地平面 14，如由 16 所指示。带电 RF 连接 17 从放在下面的电路（未示）通过接地平面 14 延伸到在 18 上的辐射元件 12。PIFA 通过调整能影响增益和带宽的下列参数调谐到所要求的频率：改变辐射元件 12 的长度 L；改变辐射元件 12 和接地平面 14 之间的缝隙 H；以及改变接地和带电 RF 连接之间的距离 D。接地平面的尺寸也是重要的调谐参数。为调谐 PIFA，可以调整本专业技术人员熟悉的其他参数，但不在此进一步讨论。

现在参照图 2A－2C，说明按本发明优选实施例的一种双频带分集天线 20。天线 20 包括一个介质基片 22，例如一块玻璃纤维电路板，

具有相对的第一和第二表面 22a 和 22b.用作基片的具体优选材料是 FR4 板，它是电路板专业技术人员所熟悉的．但是可使用不同介质材料用作基片 22.

对于所说明的实施例，介质基片 22 最好其介电常数在 4.4 和 4.8 之间．但应理解使用具有不同的介电常数的介质基片不脱离本发明的精神和范围．

按本发明的分集天线特别适合雷利（视线和－主反射）和雷森（Ricean）（多反射）衰减两者的争论．本发明允许该分集天线驻留在一个很小的移动无线电话中，而且当主天线进入一很大衰减区域时进行帮助．

介质基片 22 的尺度可以非常依赖于在其中包括分集天线 20 的无线电话机或其他通信设备的空间限度．一般地，介质基片 22 的厚度 T 在 1.0 和 1.5 毫米（mm）之间；宽度 W 在 11 和 22mm 之间；而长度 L 在 21 和 23mm 之间．

一铜的或其他导电材料层固定到第一和第二基片表面 22a 和 22b，并分别表示为 24a 和 24b．一种优选导电材料是铜带，这是因为当调谐天线时能容易地除掉其部分．一般地，在每个相应基片表面 22a，22b 上的导电层 24a，24b 的厚度在 0.5 盎司（OZ）和 1.0 OZ 的铜之内．

如图 2B 中所示的，接地接线端 27 和带电 RF 馈电点 28 电连接到导电层 24a．根据所要求的输入阻抗选择基片第一表面导电层 24a 上的接地接线柱 27 和带电 RF 馈电点 28 的位置．如图 2C 中所示的，一个同轴接头 29 通过但不电连接到基片第二表面导电层 24b 延伸．如下面将描述的，接地接线柱 27 和带电 RF 馈电点 28 通过同轴接头 29 电连接到放在下面的无线电话机中电路（未示）．

固定到基片第二表面 22b 的导电层 24b 是一无源导电层；即，它不电连接到天线 20 的其他部分．如本专业技术人员了解的，无源电磁元件耦合以及“断馈”（feed off）近场电流（即在一导电表面上流动的电流存在在靠近导电表面的电流感生的电磁场的“场”中）．无源天线并不由 RF 源直接激励的天线，而是由另外源辐射的能量激励的天线．无源元件的存在可以改变靠近天线的谐振特性，从而允许天线谐振在多于一个的频带中．

如下面将描述的，第一和第二基片表面 22a，22b 和在其每个上面

的相应的导电层 24a，24b 起到如 30a 和 30b 所示的相应的辐射元件的功能．辐射元件 30a 称为“馈电”辐射元件，而辐射元件 30b 称为“无源”辐射元件．如下面将描述的，馈电和无源辐射元件 30a，30b 允许天线 20 调谐使其在至少两个频带内谐振．

参照图 2B 和 2C，每个导电层 24a，24b 的部分 26a,26b 分别已去掉，以产生用于辐射 RF 能量的弯曲的导电图形，分别由 32a 和 32b 表示．如那些本专业的技术人员所了解的，每个弯曲导电图形 32a，32b 的长度是一个调谐参数．馈电辐射元件 30a 和无源辐射元件 30b 使得天线 20 谐振在至少两个频带中．无源辐射元件 30b 由馈电辐射元件 30a 产生的磁场激励．馈电辐射元件 30a 和无源辐射元件 30b 最好配置来产生两个不同的谐振频率．由此，与仅仅只有单个辐射元件的天线相比，可以增加天线的带宽．

现在参照图 3，说明由按本发明的双频带分集天线得到的示例性谐振曲线 40．VSWR 沿“Y”轴标绘并由 42 表示．频率沿“X”轴标绘并由 44 表示．如由所说明的谐振曲线 40 所表示的，馈电辐射元件 30a 和无源辐射元件 30b 配置来在两个近间隔的接收频带（频带 1）和（频带 2）上谐振．频带 1 由频率 f_1 延伸到频率 f_2，而频带 2 由频率 f_3 延伸到频率 f_4．频带 1 和频带 2 是近间隔的，而且其 VSWR 低于 2：1 以便于阻抗匹配．谐振曲线 40 表示何处（指频率）天线和接收机电路间的匹配将为 0.5dB 或更低的耗损．所示双频带分集天线在两个频带上按增益做成接近 1/4－1/4 波可伸缩的天线．如由那些本专业技术人员所理解的，谐振曲线 40 通过“调谐”天线 20 是可调节的．调谐包括调节和选择如下面描述的双频带分集天线的各种参数．

参照图 4，以装配图说明在一个通信设备例如一个无线电话机中按本发明的双频带分集天线 20．天线 20 放在屏蔽罩 52 上面，并且同屏蔽罩 52 保持间距关系．屏蔽罩 52 放在电路板 54 上面，并对固定到该电路板上的各种微电子元件（未示）提供电磁干扰屏蔽．屏蔽罩 52 有一个平的外表面 53，用作天线 20 的接地平面．

在说明的实施例中，同轴接头 29 提供一个通道，用于使带电馈电元件 33 从电路板 54 通过屏蔽罩孔 31 延伸并同馈电点 28 电连接．描绘的同轴接头 29 还提供一个通道，用于接地馈电元件 35 将接地接线柱 27 同接地屏蔽罩 52 电连接，如那些本专业技术人员所理解的，最

好通过放在下面电路板 54 上的一个 RF 开关（仅接收）（未示），带电馈电元件 33 将带电 RF 馈电点 28 同接收机输入和输出端（未示）连接，该 RF 开关对接收机断开主的和分集的天线.

天线 20 的无源辐射元件 30b 通常与屏蔽罩 52 的外表面 53 保持平行间距关系. 泡沫塑料 55 或其他类似的非导电材料最好放置在无源辐射元件 30b 和屏蔽罩 52 的外表面 53 之间并用作减小振荡和振动的效应的装置.

对于所说明的分集天线 20 的调谐参数包括但并不限于：天线 20 的长度 L；介质基片 22 的厚度 D1；屏蔽罩 52 和天线 20 之间的距离 D2；带电 RF 馈电点 28 和接地接线柱 27 之间的距离 D3；以及馈电辐射元件 30a 和无源辐射元件 30b 两者的弯曲的导电图形的长度. 介质基片 22 和弯曲导电图形的长度定义辐射一种谐振结构必要的“电长度”. 接地平面，馈源和馈电分开是传统天线的改型.

以上为本发明的说明性的但并不认为其为限制性的. 虽然已描述了本发明的几个示例性的实施例，那些本专业的技术人员将容易理解，许多对示例性实施例的改进是可能的而不是明显地脱离本发明的新的技术和优点. 由此所有这样的改进被认为包括在如权利要求中所定义的本发明的范围之内. 在权利要求中，认为装置－加－功能条款覆盖在此被描述为执行所列举功能的结构，以及不仅结构等效物而且还等效的结构. 因此应理解以上所述对本发明是说明性的和不认为限制到公开的指定的实施例，而对公开实施例的改进，以及其他实施例都认为包括在所附权利要求的范围之内. 本发明由下列权利要求以及包括在此的权利要求的等效物定义.

说 明 书 附 图

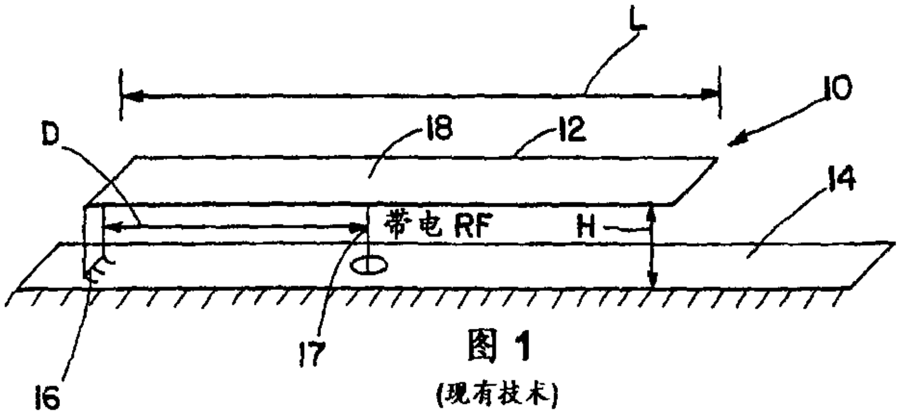


图 1
(现有技术)

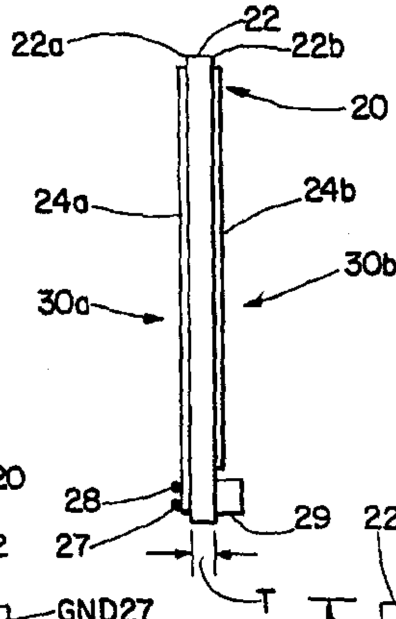


图 2A

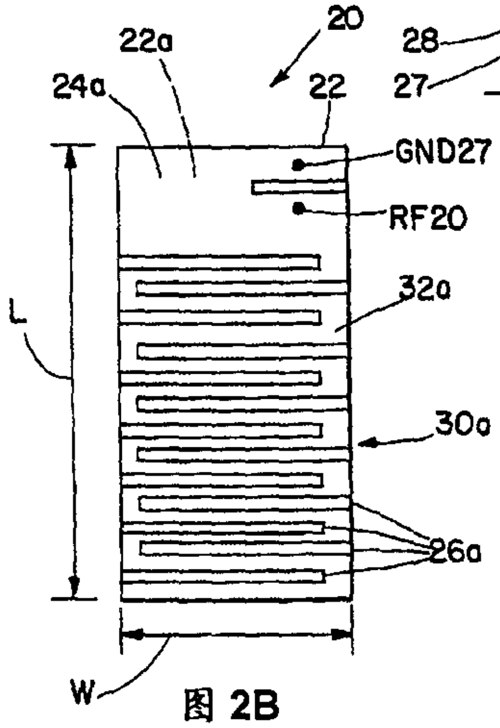


图 2B

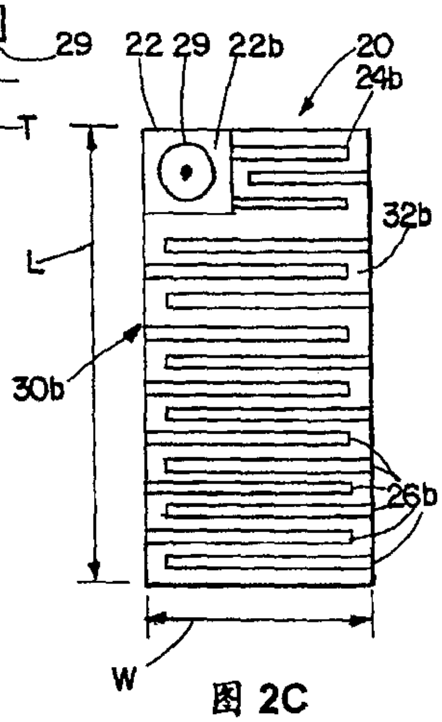


图 2C

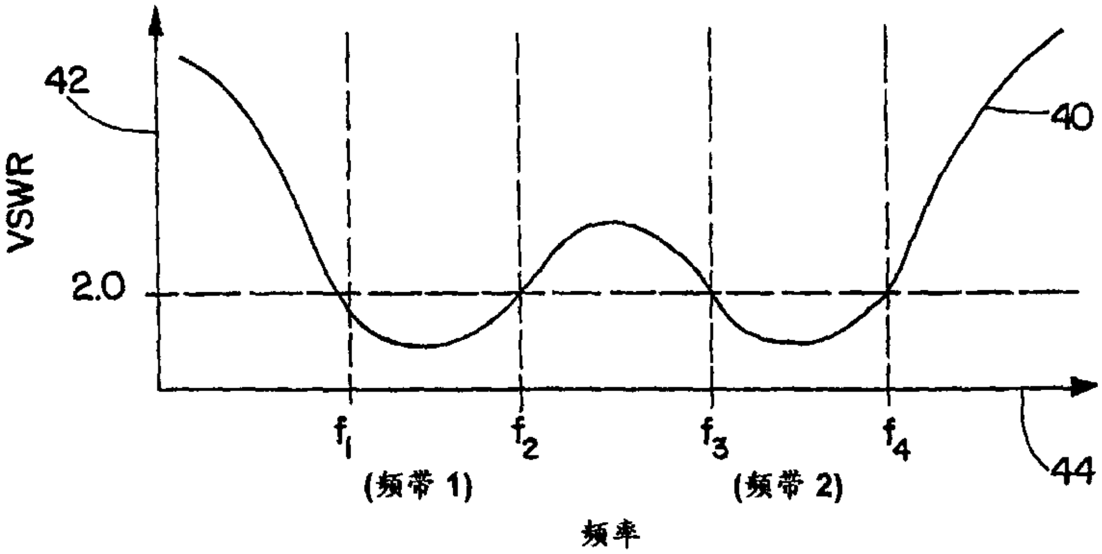

42
VSWR
2.0
40
f_1
f_2
f_3
f_4
44
(频带 1)
(频带 2)
频率

图 3

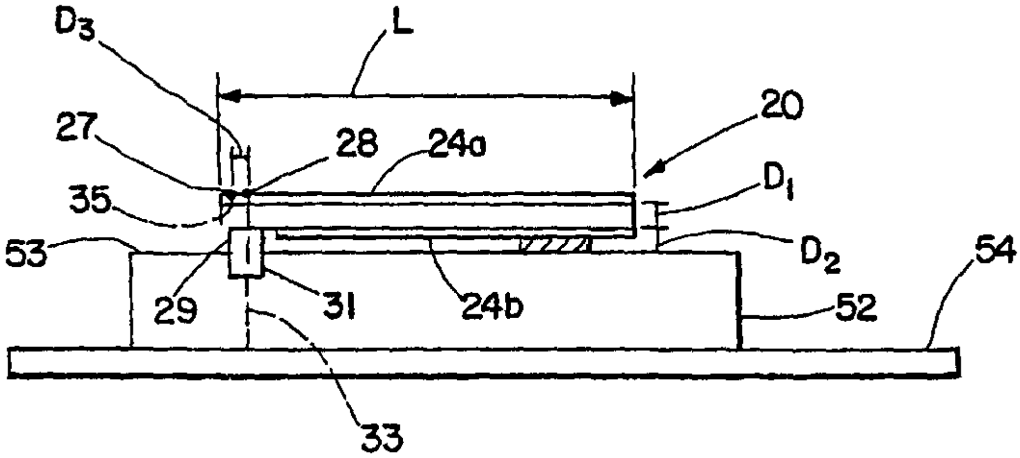

D_3
L
20
27
28
24a
D_1
35
53
D_2
54
29
31
24b
52
33

图 4